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A CONTRIBUTION TO THE DESCRIPTION OF THE FAUNA OF THE TRENTON GROUP

by

P. E. Raymond

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*A CONTRIBUTION TO THE DESCRIPTION OF THE FAUNA
OF THE TRENTON GROUP.*

By P. E. RAYMOND.

This report is intended to give the results of a study of a number of new or unusual fossils that were found in the Trenton group during a study of the Ordovician formations in Ontario and Quebec. Appended is a table of the subdivisions of the Trenton. In this table, the Utica is not considered as a separate unit but as a shaly phase of the Trenton. The name "Picton" having been used by Prof. Cushing in 1910 as a formational name for a granite, the name "Cobourg" is here used in its stead, the upper Trenton being fossiliferous in the vicinity of that town.

Subdivisions of Trenton Group.

Ontario	Quebec	New York	Zonal name (Ontario)
Collingwood	" Utica "	Utica (Northern New York)	Asaphus canadensis zone
Upper Cobourg (Upper Picton of former papers)		Upper Cobourg (Northern New York)	Hormotoma zone or "sponge" beds
Lower Cobourg (Lower Picton of former papers)	Trenton	Trenton (typical) (Trenton Falls)	Rafinesquina deltoidea zone
Trenton (restricted)			Cystid beds Prasopora zone
Hull	Glens Falls	Glens Falls (Trinucleus beds) (Mohawk valley)	Crinoid beds
Rockland (Triplecia beds)	Lorette (Parastrophia beds)		Dalmanella zone

Class, *Cystoidea* von Buch.

Genus, *PLEUROCYSTITES* Billings.

Pleurocystites laevis sp. nov.

Plate II, figures 1, 2, 3.

There occurs at Kirkfield, Victoria county, in considerable numbers, a *Pleurocystites* which has been a puzzle for several years, and which is now put forward as possibly a new species. The specimens, though common, are usually none too well preserved, and no single specimen retains all the plates in good preservation. But all plates of the antanal side have been seen, on one specimen or another, and the striking features are the total absence of pectinirhombs and surface sculpture, and the smoothness of the antanal side, no umbones being present. The arrangement of the plates (see Plate II, figure 2) appears to be as usual in *Pleurocystites filitextus* except that Plate XIV laps over onto the antanal side as in *P. squamosus*. This occurs in several specimens, and does not seem to be due to a crack, but a real suture. In the specimen figured, the plates of one side are displaced and Plate II is divided by a crack. Plate XII is broken and is not normally so long as shown in the figure, and the suture between it and Plate XI is nearly straight (see figure 3). The anal side has been observed by breaking a specimen, and though no details are visible, there is a large periproct made up of small plates.

The brachioles are like those of ordinary species of *Pleurocystites*.

The more complete specimen figured is 38 mm. long and 31 mm. wide; a small individual is 24 mm. long and 20 mm. wide; still another is 34 mm. long and 29 mm. wide.

Although this is a common and conspicuous fossil it has not been commented upon by palaeontologists who have studied the echinoderms of Kirkfield, and who may have considered it a worn specimen of one of the common forms of *Pleurocystites*. The plates of many of the specimens appear perfectly well preserved, and the sutures between Plates I and V, XI and XII, and X and XIV, where the pectinirhombs should be, are clearly marked in several. But there is no trace of pectinirhombs and it seems incredible that weathering, which usually accentuates the striations and pores, should remove all trace of them.

Bather¹ states that in this genus the lower pectinirhomb between Plates I and V is sometimes absent, and that "when this absence is correlated with other features, it can scarcely be passed over as an individual abnormality."

¹ Trans. Roy. Soc. Edinburgh, 49, pt. 2, No. 6, 1913, p. 461.

Horizon and Locality. This form is fairly common in the "crinoid beds" near the liftlock at Kirkfield, where specimens have been collected by W. A. Johnston, E. J. Whittaker, and the writer. A large slab with many specimens was collected by Dr. R. Ruedemann and is now in the New York State Museum.

Genus, *AMYGDALOCYSTITES* Billings.

Amygdalocystites radiatus Billings.

Plate II, figures 5—7.

Amygdalocystites radiatus Billings, Can. Jour. 2, 1854, p. 271, figs. 7, 8.

For later references, see Bassler's Bibliography of Ordovician and Silurian fossils.

The brachioles of this genus have not, it is believed, been illustrated, though Bather has indicated them in outline in one of his figures.¹ Two specimens found by the writer on a large slab at Healy falls, Trent river, show the remains of some of them. They prove to have been fairly long, slender, and apparently flexible organs, and seem to have a structure similar to those of *Pleurocystites*. The lower portion is made up of long plates, those on the two sides being opposite in position instead of alternating as in *Pleurocystites*, and the groove so formed is roofed by numerous small covering-pieces, those on opposite sides dove-tailing into each other. The lower plates are rather long, and there are about fifteen covering plates to five of the lower ones. The arrangement of the plates opposite to each other instead of alternating and so dove-tailing into the lower surface produces greater flexibility but results in less strength, which probably explains why the brachioles are not seen more often. The best-preserved brachioles are a little over 10 mm. long. As will be noted in the figure, a part of them bend upward and those above downward, thus indicating the position of the mouth of this individual. Another specimen shows the anal pyramid, which is composed of a circle of eight plates.

A specimen of *Amygdalocystites florealis* Billings collected by Mr. Whittaker at the liftlock shows the bases of several brachioles apparently similar to those already described, though perhaps a trifle stouter and with shorter plates (Plate II, figure 4).

Each specimen shows a small piece of column. Near the proximal end, at least, the column proves to be made up of alternating columnals, there being, however, very little difference in the diameters

¹Lankester, E. R., A treatise on zoology: Part 3, The Echinodermata By F. A. Bather, 1900, p. 57, fig. XIX, 1.

of the two kinds. The column is 2.55 mm. in diameter, at a point 2.5 mm. from a crown 26 mm. long.

Class, *Edriosasteroidea* Billings (emend. Bather).

Clarke has shown that the Devonian species of *Agelacrinites* differ from the Ordovician forms which have been referred to that genus in having mosaic, instead of imbricating, plates. Since the type of *Agelacrinites* is a Devonian species, it has become necessary, as Clarke¹ and after him Foerste² pointed out to make provision for the Ordovician forms. This need was in part met by the genus *Lebetodiscus* proposed by Bather³ after studying the incomplete specimen of *Agelacrinites dicksoni* collected by Bigsby and figured by Billings.⁴

In a paper on the species of "*Agelacrinites*" found in the Trenton of Ontario⁵ this generic name was used for all the forms there described but it was suggested that the name *Lebetodiscus* be restricted to the type-species and *L. loriformis*, and that two new genera be created for the other species. Dr. Foerste had been working for some time on the Ordovician *Agelacrinitids* and the writer, therefore, refrained from naming the genera thus forecasted. In a paper which has just appeared⁶ (April 5, 1917) Dr. Foerste has supplied the two generic names wanted.

Genus, *LEBETODISCUS* Bather.

Type, *Agelacrinites dicksoni* Billings.

Specimens of this species are rare and the best one known is that figured by the late Sir James Grant in the *Ottawa Field Naturalist*. This specimen, which was donated to the Victoria Memorial Museum, appears after comparison with Billings' and Bather's figures, to be a real *Agelacrinites dicksoni*. Bather states that *Lebetodiscus* differs from *Agelacrinites* in three essentials: (1) the absence of a differentiated marginal zone; (2) having a less flattened and less sessile habit, and (3) "the side plates, here called flooring plates, are homologous with the flooring plates of *Edrioaster*. Whether those plates have homologues in the *Agelacrinitidæ* is a matter for debate; at any rate, no genus of that family has similar plates with intervening depressions so like pores." The first two

¹ Bull. N.Y. State Mus., 49, 1901, p. 182.

² Bull. Sc. Lab., Denison Univ., vol. 17, 1914, p. 399.

³ Geol. Mag. dec. 5, vol. 5, 1908, p. 550.

⁴ Canadian organic remains, dec. 3, 1858, Pl. 8, figs. 4, 4a.

⁵ Ottawa Naturalist, vol. 24, 1915.

⁶ Bull. Sc. Lab., Denison Univ., vol. 18, 1917, p. 340 (dated Dec., 1916).

differences may be due to the imperfection of the specimen studied, and as regards the third difference, the "flooring plates" of Bather in *Lebetodiscus* are presumably the same as the "outer covering plates" of Foerste, and Bather's specimen was not so preserved as to enable him to get at the real flooring plates, which in a Canadian specimen are concave and single, not double.

(Compare Dr. Bather's fig. 1, p. 545, with Dr. Foerste's fig. 1, Pl. 1, fig. 4, Pl. 2, and fig. 4, Pl. 3, or, for the genus *Thresherodiscus*, fig. 8, Pl. 1).¹ The small plates which Dr. Bather took for the real covering-plates are the "median or intercalated covering plates" of Foerste. No real difference is apparent between the structure of the subvective system of *Lebetodiscus* and such a typical (Ordovician) *Agelacrinites* as *A. pileus*, except in the large pores between the lateral covering plates. Foerste² calls attention to the fact that in *Lebetodiscus dicksoni* all the rays are contra-solar; that the supra-oral plates differ from the lateral covering plates of the arms merely in their smaller size; that from the median ridge of the covering-plates short ridges extend off laterally, except at the tip of the plates, where the median ridge broadens out; and that there are no accessory plates along the median line of the rays. This combination of characteristics he seems to consider of generic importance.

Lebetodiscus dicksoni (Billings).

Plate I; Plate III, figure 1.

Billings, Rept. of Prog., Geol. Surv., Can., 1857, p. 294; Can. Org. Rem., dec. 3, 1858, p. 84, Pl. 8, fig. 3, 3a, 4, 4a; Chapman, Expos. Min. Geol. Can., 1864, p. 110; Grant, Trans. Ottawa Field Nat. Club, vol. 1, No. 2, 1881, fig. 9; Jaekel, Stamm. Pelmat. 1899, p. 50, pl. 2, fig. 2; Clarke, Bull. N.Y. State Mus. 49, 1901, p. 191, fig. 3; figured without name by Sowerby, Zool. Jour., 1825, 2, p. 318, Pl. 11, fig. 5.

The Victoria Museum contains four specimens of this rare species; the type; a specimen collected by Billings (No. 1415); a specimen collected by Mr. Fitzpatrick at Peterborough, Ont. (No. 1412); and the specimen from Ottawa donated by Sir James Grant and figured by him in 1881 (No. 437).

The type-specimen is very poorly preserved. Billings' specimen, also poorly preserved, has been cut so as to expose a section across arms II and III, the section of the anterior arm showing that the structure is the same as in *Agelacrinites pileus*, there being

¹ Bull. Sc. Lab., Denison Univ., vol. 17, 1914.

² Bull. Sc. Lab., Denison Univ., vol. 18, 1917, p. 341.

a single concave flooring plate, and two roofing plates meeting above the groove thus formed.

Sir James Grant's specimen of *Agelacrinites dicksoni* is the largest Agelacrinitid so far found in the Trenton, but, of course, is not so large as some of the Cincinnati forms. It is 24 mm. in diameter, and the centre of the anal pyramid is 5 mm. from the centre of the arms. It belongs to the same species as the specimen described by Dr. Bather, has the same large pores along the sides of the rays, and the same large interambulacral plates. The supra-oral series is well shown, and is of the same type as is *Agelacrinites pileus*, *A. billingsi*, and others. A single plate lies behind the centre opposite the anal inter-radius, and two lie in front, between rays II and III, and III and IV. On each side of the lower plate are two narrow lateral plates, and two small plates are outside the upper ones. The breaking up of these plates and the introduction of some of the proximal ray plates into the disk probably accounts for the large number of supra-orals seen in the specimen figured by Dr. Bather.

The inter-ambulacral areas are beautifully preserved in this specimen, showing between the arms the very large plates so characteristic of the species, the smaller but still large plates just outside the arms, and the very small ones of the outer border.

Finally, there is Bigsby's specimen on which Dr. Bather based the genus *Lebetodiscus*. It agrees with other specimens of *A. dicksoni* in having five contra-solar rays subequally spaced, in having the outer covering-plates but slightly interlocking over the rays, in having very large inter-radial plates, and in the size and position of the anal structure. It differs in lacking the outer border, but on inspection of Dr. Bather's photograph, one is easily persuaded that that is due entirely to an accident of preservation, as half the known specimens of *A. dicksoni* lack the border entirely or in greater part. There appears to be a difference between the supra-oral region of Bigsby's specimen and that of the other individuals. The arms seem to be more or less massed together to form a sort of supra-oral disk, somewhat as in *Isorophus inconditus*. The orientation of these plates cannot be determined without the specimen, but as stated above, it seems probable that the appearance of a large disk is due to the disturbed condition.

Horizon and Locality. All the individuals of this species whose exact locality is known have been found in the Cystid beds of the Prasopora zone, and about 180 feet below the top of the Trenton. Besides Peterborough and Ottawa, Pakenham, Ont., has furnished a specimen listed by Dr. Ami. The specimens from Kirkfield identified by Mr. Springer as this species are almost if not entirely all *Carneyella multibrachiata*.

Lebetodiscus loriformis Raymond.

Plate II, figure 9; Plate III, figure 2.

Ottawa Naturalist, 1915, 24, p. 56, Pl. 1, fig. 6.

This specimen has long been known to the collectors about Ottawa as one of the prizes of Dr. Van Cortlandt's collection (now in the Victoria Museum, No. 1414). It has always been considered as an abnormally long-rayed specimen of *Agelacrinites dicksoni* and there can be no doubt that it is very closely related to that species, but since it forms one of the "connecting links" with the species of the later formations it seems to deserve a name. It may be described briefly as a *Lebetodiscus* with rays so long that each one nearly touches its neighbour, all rays contra-solar, and equally spaced, the outer border of small plates narrow, supra-oral structure apparently as in *L. dicksoni*. This species is believed to be ancestral to the very long-rayed forms for which Hall erected the genus *Streptaster*.

The holotype, 23 mm. in greatest diameter, is from the Trenton at Ottawa, probably from the Cystid beds about 180 feet below the top of the formation (No. 1414).

Genus, *CARNEYELLA* Foerste.Type, *Agelacrinites pileus* Hall.

"In *Carneyella* the five plates occupying the interradial angles differ in form from the lateral covering-plates characterizing the rays; this is true especially of the two anterior and of the conspicuous posterior supra-oral plates."¹

Carneyella billingsi (Chapman).

Plate III, figure 3.

Agelacrinites billingsi Chapman, Can. Jour., 5, 1860, pp. 358, 204.*Hemicystites (Agelacrinites) billingsi* Sladen, Quart. Jour. Geol. Soc. London 35, 1879, p. 750.

Agelacrinites billingsi Chapman, Ann. Mag. Nat. Hist. third ser., 6, 1860, p. 157, fig.; Billings, Can. Jour., n.s. 6, 1861, p. 516, fig. 86; Chapman, ibid, n.s. 8, 1863, p. 199, fig. 180; Expos. Min. Geol. Can., 1864, p. 110, fig. 86, p. 171, fig. 180.

Hemicystites billingsi Jaekel, Stammes, Pelmat., 1, 1899, p. 49.

Local collectors have for a long time recognized two forms of *Agelacrinites billingsi* in Ontario, one with straight and one with curved rays.

¹ Bull. Sc. Lab., Denison Univ., vol. 18, 1917, p. 341.

Chapman's original specimen, collected at Peterborough, was of the straight-rayed variety. The species though fairly common has never been properly described or figured. Chapman's name is here restricted to the form with straight rays and the type of ornamentation described below.

Description. Specimens small, circular in outline, not ordinarily resting upon any foreign object. Rays five in number, narrow, straight, and tapering but little toward the distal end, the two rays enclosing the anal inter-radius a little farther apart than the others. Each has about thirteen pairs of alternately placed lateral covering-plates, which are truncated at the ends, so that they interlock along the median line. The points of these plates are curved so that when the ray is slightly sagged apart alternating pores are seen between the covering pieces. Over the central area, presumably covering the mouth, are three principal plates; a large one next to the anal inter-radius, and two smaller ones anterior to it.

For convenience in speaking of these fossils, the anal inter-radius is called posterior, the ray opposite to it anterior, and the rays numbered in clock-like (solar) order, beginning with the one at the left of the anal inter-radius.

The single large plate of the supra-oral series is then between rays I and V, and its great width is due to the enlargement of the posterior inter-radius by the anal opening. The other two plates are inter-radial in position, one being between rays II and III and the other between III and IV. There are also two other narrow, five-sided plates accessory to the supra-oral system, one between rays I and II and the other between IV and V. These at their proximal edges abut against the anterior supra-oral plates. Numbering them according to the inter-radial areas which they oppose, the broad posterior one is 5, the next one to the left 1, the first anterior lateral 2, second anterior lateral 3, and the right posterior lateral 4.

There can be no reasonable doubt that Chapman's specimen had this structure. In his principal description in the *Ann. Mag. Nat. Hist.* he says: "These rays at their origin leave a small central space covered by larger and somewhat rhombic plates. The latter appear to be five in number, and to constitute the first ray plates, one being common to two adjacent rays."

No two of the covering-plates, either of the rays or of the supra-oral system, seem to be in any way joined together, but all were probably movable. The three principal supra-oral plates, Nos. 2, 3, and 5, are of such form and strength as to suggest that they could have functioned as jaws.

The inter-radial spaces are covered with small imbricating plates, and the anal opening is surrounded by a small pyramid of six triangular pieces.

Just outside the tips of the rays is a ring of large thick plates ornamented with pits and rather large granules. Two or three of these plates are opposite each inter-radius, except the posterior one, which has four. They are much thicker and less scale-like than is usual in this group of fossils and such ornamentation is unique in the family.

Chapman stated that his specimen was $\frac{1}{2}$ inch (12.7 mm.) in diameter. Specimen 1413 is 12 mm. in diameter, and another (5393) is only 10 mm.

The plate structure as here described seems to be common to several species of *Carneyella* and *Cytaster*.

Horizon and Locality. This species as now restricted is fairly common, but only at the type-locality. The original specimen was found at Peterborough, probably in the Cystid beds of the *Prasopora* zone in an old quarry near the entrance to Jackson park, where several specimens of *Agelacrinitids* have been collected.

Carneyella youngi (Raymond).

Plate III, figure 4.

Ottawa Naturalist, 1915, 24, p. 58, Pl. 1, fig. 4.

This species, named after G. A. Young of the Geological Survey, is very like *C. billingsi*, having straight rays, the same suproral structure, and about the same size. It differs in lacking the thick, ornamented plates of the outer ring, and the rays are broader. The inter-ambulacral areas are covered with large, transversely elongated, scale-like, imbricating plates, about fifteen to each of the lateral and anterior areas, whereas in the posterior inter-radius they are somewhat smaller and more numerous. The anal opening is surrounded by two circles of small plates, five or six of which are in the inner circle. Outside the area to which the rays extend is a narrow margin of smaller imbricating plates.

The holotype (No. 3234, Victoria Museum) is from lot 12, con. 1, London, Ont., where it was collected from the upper part of the *Prasopora* zone of the Trenton by W. A. Johnston.

Carneyella chapmani (Raymond).

Plate II, figure 8; Plate III, figure 6.

Ottawa Naturalist, 1915, 24, p. 58, Pl. 1, fig. 3.

This species differs from *C. youngi* in having longer and more slender rays, all of which show a slight curvature in the contra-solar

direction, and also in having a wider border of small plates. The arrangement is the same as in *C. youngi*, but the lateral covering-plates are not so narrowly pointed on their inner ends. No median covering pieces have been seen.

The specimen selected as the holotype is 18 mm. in diameter.

This is one of the forms which have been identified usually as *A. billingsi*, but it persistently differs from it, as well as from *C. youngi* in the points mentioned, and is intermediate in characteristics between *C. billingsi* and *C. pileus* of the upper Ordovician.

Ray I of this species is almost straight, the only curvature being just at the point where it joins the peristomal plates. At the outer end there is no curvature.

Ray IV is the most curved of any on the type and all show the greatest curvature at about half-way between centre and margin.

Horizon and Locality. The holotype (No. 3235 Victoria Museum), was collected by W. A. Johnston from the Cystid beds in the Prasopora zone of the Trenton in an abandoned quarry near the entrance to Jackson park, Peterborough, Ont. The same form has been found in the Prasopora zone at Fenelon Falls and Brechin, Ont., and in the Cystid beds at Ottawa, Ont., and Hull, Que.

Carneyella platys (Raymond).

Plate III, figure 7.

Ottawa Naturalist 1915, 24, p. 59, Pl. 1, fig. 5.

This species is based upon a single specimen which has long been in the Museum of the Geological Survey. It is imperfect, having been cut off by a joint along the anal side, thus losing the distal ends of rays I and V. The specimen is otherwise quite well preserved. The outline is rounded-pentagonal, its greatest diameter being 24 mm., and the arms are long, reaching nearly to the margin. The rays are nearly straight, though the posterior ones probably curved toward each other somewhat, partly enclosing the anal structure. Such a curvature is suggested by such parts as remain. The anal pyramid is entirely missing, but was probably small and far from the mouth. The inter-radial spaces are covered with small, thin, imbricating plates, those near the margins being much larger and thicker than the others. The plates along the rays alternate in position, there being about twenty-four or twenty-six pairs. The inner ends are diagonally truncated and pointed, so that, where undisturbed, they fit together very closely. Where they have been displaced, as is the case with most of the arms, they are drawn somewhat apart, and thus leave alternating openings.

The plates above the mouth are like those in *C. billingsi*, the anterior pair between rays II and III, and III and IV being clearly seen, and the posterior one less distinctly. At the end of each ray is a small central terminal plate, suggesting the ocular of a starfish.

This species is like *C. chapmani*, but differs from it in its larger size, longer and more slender arms, less circular outline, and the curvature of rays I and IV.

Horizon and Locality. The type and only known specimen (No. 7941 Victoria Museum) was collected at Ottawa by the late T. C. Weston in 1881, probably from the Cystid beds at the foot of Parliament hill or from Queens wharf.

Carneyella multibrachiata (Raymond).

Plate III, figure 5.

Ottawa Naturalist 1915, 24, p. 60, pl. 1, fig. 2.

This is a small *Carneyella* remarkable for the possession of eight rays instead of the usual five. Rays I and V are far apart and curve somewhat toward each other, thus partly embracing the anal area, but all the others are approximately straight. Rays I, II, and IV are bifurcated, I and II near the centre, and IV half-way between the centre and the margin. The disk is not symmetrical, ray III being crowded to the right of its normal position and rays I and II taking up as much space as III, IV, and V. All are short and the border outside them is wide, with rather large imbricating plates opposite the inter-ambulacral areas, and a margin of small ones outside. The supra-oral plates are of the simple type of *C. billingsi*, *C. chapmani*, *C. youngi*, and *C. pilea*, No. 5 being a large, wide one and the two anterior to it small. The inter-ambulacral areas are small, and are covered with small plates. Unfortunately the anal area is not well preserved. The type is 10 mm. in diameter.

This form, with its numerous arms, naturally suggests *Thresherodiscus ramosus* Foerste, but is really not allied to that species, which has three primary rays all of which bifurcate at least twice. The present species is much more closely allied to *C. chapmani* and to *C. billingsi* and when first noted several years ago was supposed to be an abnormal specimen of one of these species. It is of interest to note that this form is found at the same horizon, the Crinoid layers (Hull formation) in the lower part of the Trenton, as *Thresherodiscus ramosus*, these being the oldest of the described *Agelacrinitidæ*. Owing to the imperfections of the Kirkfield specimen it is not known how many are to be referred to this species. One seems to have only six rays, and it is possible all are abnormal individuals of a five-rayed species.

The holotype (No. 7789 Victoria Museum) is from the Crinoid beds (Hull formation) at Kirkfield.

Carneyella raymondi Clark.

Bull. Mus. Comp. Zool., vol. 63, No. 1, 1919, p. 11, Pl. 1, figs. 18, 19.

Mr. Clark has recently described a small Agelacrinitid from the middle Trenton near Martinsburg, N.Y., which is comparable to *Carneyella multibrachiata* in that it has more than five arms. In this species ray II alone is bifurcated, so that six arms are produced. Both have the rays nearly straight, the oral region somewhat larger than usual, and both seem to belong to the same group as *Carneyella youngi*.

GENUS, ISOROPHUS Foerste.

Type, *Agelacrinites cincinnatiensis* (Roemer).

"In *Isorophus*¹ the supra-oral plates differ only slightly from the lateral covering-plates of the rays, and the genus is regarded as more primitive in type. To *Isorophus* are referred *Agelacrinites cincinnatiensis* Roemer, *Agelacrinites holbrooki* James, and *Lebetodiscus inconditus* Raymond. In all these species accessory covering-plates are present along the median line of the rays."

Isorophus inconditus (Raymond).

Plate IV.

Ottawa Naturalist, 1915, 24, p. 61, Pl. 1, fig. 1.

This is the form, so common in the Cystid beds below Parliament hill and at Queens wharf, Ottawa, which has always been identified as *Agelacrinites billingsi*. It differs in several respects from that species.

Description. Specimens circular in outline with a broad border of small plates. Rays five in number, rather stout, broad at the proximal end, and tapering rapidly. They are almost straight in small specimens whereas in large ones they are slightly curved, four having a contra-solar turn, and the fifth curved a little in the opposite direction, so as to embrace the posterior inter-radius. Rays I, II, and III of some specimens are contra-solar, and IV and V solar, whereas in the one selected as the holotype, IV is almost straight. They bear short interlocking lateral covering-plates, about twelve to

¹ Bull. Sc. Lab., Denison Univ., vol. XVIII, 1917, p. 341.

fifteen pairs each. Median covering-plates have not been seen. An appearance of unusual width is given to the rays by the fact that the plates of the inter-radial which abut against them are somewhat higher than the remainder of those in the inter-radial spaces.

The supra-oral area is large, and covered by numerous small plates. Their arrangement is difficult to make out, the inter-ambulatory plates being peculiarly mixed with ray and supra-oral series. In the centre of the disk there appears to be a central plate dove-tailing into two plates that are between rays I and V, and abut on the posterior inter-radius. At the sides and in front of the central piece are five more small plates, one on each side and three in front. Two are inter-radial in position, one between rays II and III, and one between III and IV. This is on the type, but on the small specimen next to it in the figure, there seem to be only five plates which really belong to the supra-oral series, the central, two posteriors, and two anterior laterals, between rays II and III, and III and V.

The inter-radial areas are covered with small imbricating plates, those of the inner part of the outer marginal band being somewhat larger and wider than those between the rays. The posterior inter-radius is wider than the others, and the anal pyramid is large and distinct. Situated a little more than half-way from the centre to the margin, it is composed of a ring of seven or eight, long, triangular plates. In some specimens it is observed half-way between rays I and V, in others it is eccentric, and nearer V than I, as in the type.

The holotype is a large individual, 15.5 mm. in diameter. Other specimens on the same slab with it (all figured) are 11.5, 10, and 9 mm. respectively.

This species differs from *Lebetodiscus dicksoni* in having shorter rays, one or two of which are solar, and in having much smaller inter-radial plates. It more nearly resembles *Carneyella platys*, but has more supra-oral plates. Though small specimens of *Isorophus inconditus* have straight, broad arms, they may readily be distinguished from *Carneyella billingsi* or *C. youngi* by the greater number of supra-oral plates.

Horizon and Locality. This species is common in the Cystid beds in the Prasopora zone on both sides of Ottawa river at Ottawa and Hull. It occurs at Peterborough also.

The holotype (No. 1409 Victoria Museum) was collected by Mr. T. C. Weston and is undoubtedly from Queens wharf.

Class, **Brachiopoda** Duméril.

Genus, **PSEUDOLINGULA** Mickwitz.

Pseudolingula iowensis (Owen).

Plate V, figures 1, 2.

Lingula iowensis Owen. Geol. Rep. Iowa, Wis., and Ill., 1844, p. 70, Pl. 15, fig. 1. For further synonymy, see Bassler, Bull. 92, U.S. Nat. Mus., pt. 2, 1915, p. 729.

Since this shell, which is rather common and widespread in the Ordovician of Iowa and Minnesota, has not previously been indentified from the more eastern Trenton, the opposite valves of a fairly well preserved specimen have been figured.

Locality. The species has been found in Ontario only in the upper part of the middle Trenton at Trenton, Ont., where it was collected by E. J. Whittaker and the writer.

Genus, **DALMANELLA** Hall and Clarke.

Dalmanella rogata (Sardeson).

Plate V, figures 5, 6.

Orthis rogata Sardeson. Bull. Minn. Acad. Nat. Sc. 3, 1892, p. 331, Pl. 5, figs. 1-4. Am. Geol. 19, 1897, p. 95, Pl. 4, figs. 1-10.

Dalmanella testudinaria Hall and Clarke (*partim*). Pal. N.Y., 8, pt. 1, 1892, Pl. 5B, figs. 27-31. Winchell and Schuchert, Pal. Minn., 3, pt. 1, 1893, p. 441, Pl. 33, figs. 17-22.

Orthis and *Dalmanella testudinaria* (*partim*) of many authors, including most references to specimens from the American Trenton.

It has been customary to call most of the American middle and upper Ordovician *Dalmanellæ*, *Dalmanella testudinaria*, but it is now admitted that the so-called species is capable of subdivision though no one seems to have proved that the real *Dalmanella testudinaria* is found in America.

Dalman's¹ figures are very poor, though not so bad as the reproduction in volume 8 of the Palæontology of New York. Fortunately the Museum of Comparative Zoölogy contains three specimens of this species collected in 1832 by Marklin at the type-locality at Borenshult, Oestergotland, Sweden. A photograph of the opposite valves of the best specimen is presented here (Plate V, figs. 3, 4). The shell

¹ Kong. Vet. Acad. Handlingar, 1827. Reprint of 1828, p. 31, Pl. 2, figs. 4a-e.

is of the same size and shape as the common American form usually referred to this species, but the striations are not the same, and agree with Dalman's description.

To Sardeson is due the suggestion of studying the striæ of *Dalmanella* according to the number and arrangement of the fascicules, and it is when the shells are viewed in this way that the difference between the American and Swedish forms is best seen. Sardeson pointed out that in *Dalmanella rogata* eleven principal striæ extend to the beak or cardinal margin and that the shell is covered by lines produced by the bifurcation of these. The same sort of thing is seen in the Swedish form, but as the branching takes place closer to the beak, there are more of the strong prominent striæ. There are, as Dalman says, two kinds of striations, about thirty elevated ones which reach the beak, and between them, shorter and finer ones, two or three of which lie between each pair of elevated ones. On *Dalmanella rogata* this alternation of elevated and weak striæ is not so readily observed, because many of the short striations are as coarse as the long ones.

On the particular specimens at hand, there are the same number of striæ on the Swedish and American specimens. Thus, on specimens of the same length (11.5 mm.) there are six in 3 mm. on the front of the pedicle valve of each.

The difference between the two species is, therefore, small, consisting principally in the greater uniformity in size in the striations in the American species. The American species is also a little less circular than the Swedish form, the hinge being wider, and consequently, the cardinal area larger. The measurements compare as follows.

D. testudinaria—length 11.5 mm., width, 12 mm., cardinal area 6.5 mm. wide.

D. rogata —length 11.5 mm., width 12 mm., cardinal area 8 mm. wide.

Dalman's specimen was larger, 15 mm. long and 15 mm. wide.

Dalmanella rogata. Shell sub-circular in outline, plano-convex; the pedicle valve moderately convex, with a well-defined median ridge; brachial valve slightly convex with a well-defined median sinus, sharp at the beak, but gradually becoming broader and in old specimens flattening out at the front. Surface marked by from 80 to 120 fine striæ, the result of the repeated bifurcations of about eleven primary ones which reach the apex. On the pedicle valve is a median striation which is stronger than the others.

Horizon and Locality. Very common throughout the Black River and Trenton of Canada and the United States.

Dalmanella whittakeri sp. nov.

Plate V, figures 11-14.

Shell large for the genus, plano-convex, wider than long, wide at the hinge. The pedicle valve is moderately convex, highest on the umbo, and lacks a median ridge. The pedicle valve of young specimens is only slightly convex. Brachial valve almost absolutely flat, with a slight median groove near the apex. The surface is marked by exceedingly fine, thread-like striae which increase rapidly by bifurcation and show a distinct difference in coarseness, there being ten or twelve finer striae between a pair of coarse ones on the front of large shells. Interior unknown.

The largest specimen (used as holotype) is 18 mm. long, 25 mm. wide, and the hinge is 22 mm. long (estimated from unbroken half). A smaller specimen is 12 mm. long, 18 mm. wide, and the width at the hinge is 12 mm. This specimen has eight striae in 3 mm. at the front and the type has ten in the same interval.

This species differs from the common *D. rogata* in its greater size, greater width at the hinge, and finer and more numerous striae. Beside *Dalmanella rogata*, three other species are known from the Black River and Trenton. *Dalmanella hamburgensis* Walcott is a small shell, with few striae. *Dalmanella fertilis* Bassler has been figured but not described. It seems to be very closely allied to *D. rogata*. *Dalmanella bassleri* Foerste has been described but not figured. This species is of the size of *D. whittakeri*, but according to Foerste, the striae are coarse. It is found in the Cynthiana formation of Kentucky.

Horizon and Locality. Found originally in the Prasopora beds of the Trenton at Peterborough, Ont., where it is not uncommon. Mr. T. H. Clark has more recently obtained specimens from the middle Trenton (280 feet above the base) on Roaring Run, near Martinsburg, N.Y. Named for E. J. Whittaker, who with the writer, collected the types.

Dalmanella resupinata sp. nov.

Plate V, figures 7-10.

This *Dalmanella*, at first sight very like *D. rogata*, differs from that species in having a shorter hinge, and hence more nearly circular shape, and in lacking both the sinus on the brachial valve, except as a faint depression near the beak, and the median ridge on the pedicle valve. A remarkable feature, and the one which suggested the name, is that in senile individuals there is a shallow sinus developed on the front of the pedicle valve, and a corresponding low elevation on the

brachial shell. Young specimens show no trace of this, but it is feebly developed on adults (shells 13 mm. long). The striations are practically the same as in *D. rogata*.

Young specimens can be distinguished from *D. rogata* by the shorter hinge, and absence of the sinus in the brachial valve and ridge on the pedicle valve.

The holotype is 16 mm. long, 18 mm. broad, and the width at the hinge is 9 mm. The paratype is 10 mm. long, 10.25 mm. wide, and the width at the hinge is 5 mm.

This species agrees very well in outline with *D. testudinaria* (Dalman), but lacks the alternating striæ of that species.

Horizon and Locality. Found only at the north end of Grand island, Balsam lake, Victoria county, Ont., where the types were collected by E. J. Whittaker. The horizon of these beds is still in doubt but is probably upper Black River, and certainly below the Crinoid beds of the Trenton. It is associated with *Dalmanella rogata*.

Genus, *PLATYSTROPHIA* King.

Platystrophia amœna McEwan.

Plate VI, figures 1-5, and 11.

Platystrophia amœna McEwan, Proc. U.S. Nat. Mus., vol. 56, 1919, p. 412, Pl. 43, figures 1-8.

Platystrophia lynx and *biforata* (*partim*) of authors.

Recent work on *Platystrophia* by McEwan has broken up the old "*Platystrophia biforata* var. *lynx*" of America into a very large number of named species. The one here referred to is that most frequently found in the Canadian Trenton.

Description. Shell below the average size for the genus, the valves moderately and subequally convex, the plications not coarse, and, especially at the sides, rather sharp; those on the fold often more broadly rounded. The greatest width is at the hinge, the cardinal angles usually projecting a little even in old specimens. The sinus is shallow, flat-bottomed, or slightly concave, the fold very slightly elevated and with a gently convex or flat crest. The great majority of specimens have three plications in the sinus and four on the fold. The median plication in the sinus is often noticeably stronger than the others, and there is a corresponding median furrow on the fold separating the two pairs of plications. There may be as many as six plications in the sinus and seven on the fold, but such specimens are unusual. Specimens with four plications in the sinus and five on

the fold are not uncommon, and such forms arise by the bifurcation of one of the outer plications on the fold and the implantation of a corresponding plication in the sinus. The specimens with the extra plications are usually, though not always, larger than the average. Specimens from the Prasopora beds at Trenton, Ont., usually show five plications in the sinus and six on the fold, though individuals with the normal number ($\frac{4}{3}$) are present. The number on each side of the fold and sinus is variable. There may be from seven to ten on the brachial and from eight to eleven on the pedicle valve; nine on one valve and ten on the other seems the most common number.

The interior of one of these shells is rarely seen. A pedicle valve from Trenton Falls, N.Y., shows a very small and short muscle scar, which is not at all thickened. Another from Peterborough, Ont., shows a scar twice as long, much thickened at the front. The age of the individual has, of course, a great deal to do with the thickening of the scar, and it is probable that the specimen figured represents the scar of the normal adult of the species (Plate VI, figure 3).

A good-sized adult is 19 mm. wide at the hinge, 12 mm. long, and 10 mm. thick. Another is 17 mm. wide, 11.5 mm. long, and 9 mm. thick. An old individual is 15 mm. wide, 12.5 mm. long, and 12 mm. thick. All the above are from Trenton Falls, N.Y., and are in the Museum of Comparative Zoölogy, Cambridge, Mass. A specimen from Trenton, Ont., is 20 mm. wide, and 13 mm. long. One from the Cobourg beds at Picton, Ont., is 19 mm. wide, 12 mm. long, and 10 mm. thick.

Foerste has described another Trenton form of *Platystrophia* (*P. colbiensis*) from the Cynthiana formation of Kentucky. From his description and figures it appears that *P. colbiensis* differs from *P. amœna* in having the hinge width always less than the greatest width, in having fewer plications at the sides of the fold and sinus (8-9), and in being somewhat longer. Dr. Foerste has separated as varieties, specimens having the greatest width at the hinge and individuals with extra plications in the fold and sinus. The shells of both varieties are larger and longer than in *P. colbiensis*, and none is so transverse as the shells from Canada and New York. Certain specimens from Trenton Falls may perhaps be identified as *P. colbiensis*, but the great width at the hinge differentiates most of them.

Many small *Platystrophias* are found in the Eden at Cincinnati, but they are almost uniformly characterized by higher and more convex folds, and stronger plications than those in the Trenton and usually there are fewer plications at the sides. It would, however, undoubtedly be possible to pick out from the almost endless varieties

in the region of Cincinnati, specimens which would correspond very closely with *P. amœna*.

Horizon and Locality. The species as here defined is found throughout the Trenton from the base to the top, but is not especially common except at certain horizons. At Trenton Falls it is abundant at two horizons, one 175 and the other 240 feet above the base. The lower zone is at the top of the *Prasopora* beds and the upper one in the "*Rafinesquina deltoidea* beds." In Canada it is not especially abundant anywhere, though common enough at various places.

Platystrophia champlainensis McEwan.

Plate VI, Figures 6-9.

Platystrophia trentonensis champlainensis McEwan, Proc. U.S. Nat. Mus., vol. 56, 1919, p. 407, Pl. 42, figs. 9-11.

Cummings, in his brilliant paper on the "*Morphogenesis of Platystrophia*," pointed out that in the common American Ordovician *Platystrophias*, the young shell had first one plication in the sinus, and that new ones were added by implantation at the sides, whereas in European species of the same genus, the median plication bifurcated, so that, fundamentally, there are three plications in the sinus of the American forms, and two in the European. He referred, however, to the fact that in the basal Trenton of the Champlain valley, there is a small form which follows the European rather than the American method in the introduction of plications on the fold and sinus.¹ This small shell is fairly common at Montreal in the lowest layer of the Trenton and as one of the oldest, if not the oldest, of American *Platystrophias*, it is deserving of a specific name.

Description. Shell small, the valves subequally convex, with a shallow sinus and low, flat-topped fold. The hinge line is considerably less than the greatest width, the cardinal angles projecting but slightly. Cardinal areas narrow, the beaks incurved, that of the pedicle valve extending slightly beyond the other. On all specimens so far seen the sinus contains three plications and the fold four. The outer pair of plications in the sinus are produced by the bifurcation of the original single plication, and the third one is implanted between them. The median pair on the fold arise from a single one near the beak, the outer pair being the original plications. On the sides there are seven to eight ribs on the brachial valve, and eight to nine on the pedicle valve. The largest specimen is 11 mm. long and 14 mm. wide; the smallest, 6 mm. long and 7 mm. wide; the holotype, 9 mm. long, 13 mm. wide, and 8 mm. thick.

¹ Am. Jour. Sc., vol. XV, 1903, p. 9 and p. 41.

Horizon and Locality. Rather common in the lowest beds of the Trenton (Lorette) at Montreal (near corner Christopher Columbus and Bellechasse streets, Mile End), and in the Lower Trenton (Glens Falls) at Crown Point, N.Y.

Platystrophia minuta sp. nov.

Plate VI, figure 10.

Several specimens of this small shell have been collected, but all except one are brachial valves. These indicate a small biconvex shell, almost circular in outline, with a short hinge and sharp, narrow fold and sinus. The fold shows two plications which bifurcate about midway, thus producing four at the front. This is the typical American method of introduction of plications, so that these specimens cannot be regarded as the young of the last species (*P. champlainensis*). The sinus of the single pedicle valve shows only a single plication. It is, however, a very small shell, and the adult undoubtedly had three. There are four plications on each side of the fold on the brachial valve, and five on each side of the sinus of the opposite one. The holotype (brachial valve) is 6 mm. long, and 7 mm. wide; the paratype (pedicle valve) is 4.5 mm. long and 5 mm. wide.

Cumings figured a shell from Prof. Schuchert's collection¹ which probably belongs to this species. This specimen was from Montreal and though the exact horizon and locality are unknown, Cumings was probably correct in surmising that it came from the lower 10 feet of the Trenton. He says of his specimen, which is 5 mm. long, that there are "but four to seven plications on the slopes; the shell is narrowest at the hinge line, and considerably less transverse than the Trenton Falls type (the index is 1.23 in the specimen figured, which is about an average individual). The second and third plications of the sinus arise about 4 mm. from the beak."

The writer has not met with this species at Montreal, but from the occurrence at Lorette, there is every reason to believe that it occurs in the quarries at Mile End.

Platystrophia minuta differs from other American species of the genus in its very small size, and the late appearance of the secondary plications in the fold and sinus, as well as in the small number on the sides of the shell.

Horizon and Locality. Known definitely only from the lowest Trenton (Lorette) in the gorge at Lorette, Que., where the types were collected by E. J. Whittaker.

¹ Am. Jour. Sc., 15, 1903, p. 22, fig. 9.

Genus, *RAFINESQUINA* Hall and Clarke.

Rafinesquina camerata (Conrad).

Plate VI, figures 12, 13; Plate VII, figure 2.

Strophomena camerata Conrad. Jour. Acad. Sc., Philadelphia, 8, 1842, p. 254, Pl. 14, fig. 5. Emmons, Am. Geol., 1, pt. 2, 1855, p. 197.

Leptaena camerata Hall. Pal. New York, 1, 1847, p. 106, Pl. 31A, figs. 2a, b.

It is difficult to see why this quite distinct species has been united with *Rafinesquina deltoidea*. The outline of the shell is much less triangular, the convexity is much more even, the highest point being near the middle of the shell, and there is no abrupt geniculation. The interior is covered with small papillæ, thus producing a very punctate appearance in natural casts or in partly exfoliated shells, as in Hall's figure. This is not seen in *R. deltoidea*. Conrad, in his figure, shows the hinge line much less than the greatest width, but as his illustration is a perspective drawing, exact proportions are not to be expected. Hall figured the specimen which he considered to be Conrad's type and it has the same proportions as the shell here referred to this species. Many of the specimens have faint concentric wrinkles, especially near the hinge.

A moderate-sized specimen has a width on the hinge of 22 mm. and length of 20.5 mm.; a large specimen is 29 mm. wide at the hinge, and 26 mm. long.

This species has to some extent the shape and form of *Rafinesquina minnesotensis*, but the muscle-scars do not cover so large an area, and the interiors of the shells are strongly pustulose.

Horizon and Locality. This species was originally based upon a "specimen found by Mr. Vanuxem in New York." Hall gives the locality without hesitation as Trenton Falls, but does not state any reason. The writer has not seen it at that locality.

In Canada, Mr. Whittaker collected specimens near the top of the Trenton (Upper Cobourg) at Wellington, Prince Edward county, Ont., and W. A. Johnston obtained several at the same horizon on the northwestern corner of Georgina island, lake Simcoe. The species is, however, most abundant in the Collingwood, both at Collingwood, Simcoe county, and Ottawa.

Rafinesquina præcursor sp. nov.

Plate VII, figure 5.

Leptæna alternata Hall (*partim*). Pal. N.Y., 1847, 1, Pl. 31A, figs. 1f-1h.

This form, allied to *Rafinesquina deltoidea*, deserves recognition because of stratigraphic value. It is found in the upper Prasopora beds and indicates the approach to the *Rafinesquina deltoidea* beds at Trenton Falls; in Ontario it is found in the Prasopora beds, along with *Remopleurides*, *Amphilichas trentonensis*, and other species which are believed to hold a position just below the base of the true "deltoidea" beds.

This variety is triangular in shape and somewhat nasute in front. The surface is covered with alternating striæ, one or two fine ones between each pair of coarse ones. It differs from *R. deltoidea* in having less of a flattened area on the valves, in having the geniculation near the middle and less abrupt, and in the total lack of the concentric wrinkles which are usually so characteristic of that shell, but which are sometimes almost or quite lacking.

Horizon and Locality. Found in the upper part of the Prasopora beds at Trenton Falls, N.Y., and at Trenton, Ont., where the holotype was collected by E. J. Whittaker and the writer.

Genus, STROPHOMENA Blainville.

Strophomena trilobata (Owen). /

Plate VII, figure 6.

Leptæna trilobata Owen. Geol. Surv. Wis., Iowa, and Minn., 1852, p. 584, Pl. 2, figs. 17, 18.

Strophomena trilobata Miller. Am. Pal. Foss., 1877, p. 138. Lesley, Dict. Foss., Penna., 1890, p. 1134, figs. 12, 13. Winchell and Schuchert, Pal. Minn., 3, 1893, p. 395, Pl. 31, figs. 12, 13. Whiteaves, Pal. Foss. Can., 3, pt. 3, 1897, pp. 169, 241. Grabau and Shimer, N. A. Index Foss., 1, 1907, p. 223, figs. 271 g, h.

Strophomena fluctuosa Billings (*partim*). Pal. Foss. Can., 1, 1865, p. 123. (Not the specimen figured.)

Specimens of this species are figured because the writer at one time believed it to be a new species, and, to his regret, his manuscript name for it has appeared in print.¹ The shell is exceedingly like

¹ Geol. Surv., Can., Sum. Rept., 1912, p. 297 (correctly listed on p. 346).

Rafinesquina deltoidea, which occurs in the same beds and even on the same slabs with it, and without good specimens it is difficult to distinguish the two, even though they belong to different genera.

Description. Shell roughly triangular, nasute in front, widest at the hinge. Brachial valve from moderately to very strongly convex, with a sharp geniculation near the middle of the valve. At the beak there is a flattened area, which is sometimes even a little concave. The pedicle valve is convex at the beak, becoming deeply concave in front of the umbo. The surface of both shells is covered with fine striæ of two sizes. The stronger are rather numerous in most shells, and have groups of four to six fine ones between them. The posterior margin and that half of the shell are in most cases covered with fine, concentric wrinkles like those of *Rafinesquina deltoidea*. Rather numerous interiors of the pedicle valve of this species have been found at Division street, Ottawa, and one or two at other localities. The muscle-scar is small and rounded, almost circular, with the usual gap in the rather thin rim at the front; at the gap the rim turns back in two converging lines to the beak. There is no trace of any median ridge or septum. Outside the scar, the surface is marked by the radiating lines of the striæ of the exterior.

Horizon and Locality. Upper part of the Trenton (Upper Cobourg), at Picton and other places in Prince Edward county, at Collingwood, and at Ottawa. In Minnesota it occurs in the Prosser limestone (*Fusispira* beds) in association with *Rafinesquina deltoidea*. In Ontario, this species becomes very abundant and seems to replace *R. deltoidea* in the upper beds of the Cobourg.

Strophomena foveata sp. nov.

Plate VII, figure 4.

Shell small for the genus, wider than long, the brachial valve gently and uniformly convex except for a flattening at the beak, and a slight sinus which extends about half-way to the front. An obscure, broad depression, just below the cardinal extremities, produces a turned-up appearance. Pedicle valve convex at the umbo and evenly concave in front. Cardinal area of the pedicle valve rather narrow, deltidium broad and low, but convex. Pedicle opening quite large, encroaching upon the beak. Both valves covered with fine, thread-like striæ which increase by bifurcation, and are somewhat irregular in appearance. Every other striation is, in general, weaker than its neighbour. Very numerous and fine concentric markings cross the radial striæ and in places produce small pits which add to the somewhat rough appearance of the surface.

Interiors unknown.

Length of the holotype, 16 mm., width 23 mm.

A surprising number of relatively rare species of *Strophomena* occur in the Trenton, but this form does not fit in with any previously described. It belongs to the group of short shells whose length is about two-thirds the width, which at once precludes comparison with *Strophomena filitexta* Hall (Plate VII, figure 3), *S. conradi* Hall and Clarke, *S. thalia* Billings, *S. trilobata* (Owen), and *S. winchelli* Hall and Clarke (Plate VII, figure 1). There still remain, however, seven species with which it may be compared.

Strophomena billingsi Winchell and Schuchert, *Strophomena trentonensis*, and *S. emaciata* of the same authors have somewhat the outline of the present species but are much flatter shells and *S. foveata* lacks the wrinkles of the second species. *Strophomena higginsportensis*¹ Foerste is likewise described as being an almost flat shell, seemingly very like *S. trentonensis*.

Strophomena scofieldi Winchell and Schuchert has a fold and sinus, and both *S. septata* Winchell and Schuchert and *S. vicina* Foerste are larger shells.

Horizon and Locality. Rare in the Prasopora zone at Peterborough, Ont., where the type was collected by E. J. Whittaker and the writer.

Genus, PLECTAMBONITES Pander.

Plectambonites youngi sp. nov.

Plate VII, figures 7, 8.

A large *Plectambonites*, concave-convex, the brachial valve following closely the contour of its opposite. Pedicle valve strongly convex, the curvature rendered irregular by one or more low, longitudinal ridges which cross the shell on or near the median line. Some of the shells show little or no trace of these ridges. The greatest width is at the hinge, which is sufficiently extended to produce small rounded "ears." The length is two-thirds the width, a proportion which holds good for both the large and the small shells in the collection.

Surface marked, as is usual in the genus, by fine, thread-like striæ of two sizes which cover the surface densely. The major striæ, from 30 to 35 in number, are irregularly spaced, so that between any pair there may be from three to six of the smaller striations, but

¹ What may we ultimately come to in the choice of specific names!

there are usually five or six. The major striæ do not all extend to the beak, about every alternate one dying out at about the mid-length, and they are about 1 mm. apart at the front in large shells. Along the hinge margin of both valves are short, diagonal wrinkles, making an angle of about 45 degrees with the hinge. These wrinkles are narrow and close together, sometimes as many as fifteen on each side of the beak. The holotype is 14 mm. long and 21 mm. wide. The largest specimen is 16 mm. long and 24 mm. wide; the smallest seen so far is 10 mm. long.

This species differs from the more common form identified as *Plectambonites sericeus* in its greater and more irregular convexity and in the uniform presence of wrinkles on the posterior margin. In its convexity it is somewhat like *P. pisum* Ruedemann¹, but is a much wider shell. The presence of wrinkles on the margin, a feature known, but not very common, among *Plectambonites* of the Trenton, suggests the shell which Ruedemann described as *Plectambonites sericeus asper* James, but which is now known as *Plectambonites rugosus* (Meek). The species described by Ruedemann from Rysedorph is not, however, the same as the one described by James and Meek from the Eden of Cincinnati, and the Rysedorph form may appropriately be known as *P. ruedemanni*, taking the specimens figured by Ruedemann² as the types. This is a much flatter shell than *P. youngi*, and its surface is characterized by exceedingly fine and sharp striæ, the grooves between them being wider than the striations. Moreover there is almost no trace of difference in size; a suggestion of alternation is seen when glancing at some specimens, but on close examination it is almost impossible to pick out the larger ones.

Horizon and Locality. From the lowest Trenton (Lorette) beds at the power-house above Montmorency falls and at Lorette, Que. Types collected by E. J. Whittaker and the writer. Named after G. A. Young, who has taken a very helpful interest in the problems of the Ordovician of Ontario and Québec.

Genus, *OXOPLECTIA* Wilson.

Oxoplectia calhouni Wilson³.

Oxoplectia calhouni Wilson, Bull. Victoria Memorial Museum, 1, 1913, p. 81, figs. 1-6, Pl. VIII, figs. 1-3.

The status of this generic name is at present unsettled. It was proposed, with the new species *O. calhouni* as the type, to supply a

¹ Bull. New York State Mus., 49, 1902, p. 19, Pl. 1, figs. 8-20.

² Bull. New York State Mus., 49, 1902, p. 18, Pl. 1, figs. 6, 7.

³ Prof. Foerste has recently examined the type-specimens of *Oxoplectia calhouni* and considers the genus distinct from *Cliftonia*.

name for those species which had the interior structure of a *Triplecia* but with a striated or plicated exterior. This was done in ignorance of the fact that Prof. Foerste had already suggested the subgeneric term *Cliftonia* for a new species which he called *Cliftonia striata*¹.

It is doubtful if all the species of striated *Triplecias* belong to the same sub-genus. In fact, the presence of a long, bifurcated cardinal process cannot be taken as a positive guarantee of relationship. Such a process is known in brachiopods that no one would ever think of classing with *Triplecia*.

Cliftonia striata Foerste and *Cliftonia? tenax* Foerste are both unlike all the other striated *Triplecias* in external appearance. *Cliftonia striata*, the type, is, of course, the only one which is here considered. This species is described as resembling a small *Atrypa*, whereas all the other striated *Triplecias* are comparable to *Platystrophia*; it is nearly circular in outline, whereas other species are distinctly wider than long; the fold is very low and the sinus shallow, but in other species the fold and sinus are prominent features.

Professor Foerste evidently did not intend to include in this new subgenus all the striated and plicated *Triplecias*, for he makes no mention of the Ordovician species and says "Possibly *Triplecia niagarensis* Hall and Clarke, is congeneric". *Triplecia niagarensis* is one of the more typically *Platystrophia*-like forms.

In *Triplecia ulrichi*, *T. niagarensis*, and *Oxoplecia calhouni*, the cardinal process stands erect, and turns somewhat backward, into the umbo of the pedicle valve. Foerste does not figure the cardinal process of *Cliftonia striata*, but says in his description: "Interior of brachial valve with a linguliform cardinal process 1.7 mm. in length, and 0.75 mm. in width at the hinge line. This process becomes broader anteriorly, and divides near the top into two short, sharply pointed, divisions." In describing the cardinal process of *Oxoplecia* one might say *upward* or *posteriorly*, but not *anteriorly*. It might be inferred from this that the cardinal process of *Cliftonia* projected forward into the valves, which is a position unlike that in any of the *Platystrophia*-shaped *Triplecias*.

The writer does not believe the identity of *Cliftonia* and *Oxoplecia* can be demonstrated, and will, therefore, use the term *Oxoplecia* for the striated or plicated *Triplecias* like *O. calhouni* Wilson, *T. ulrichi* Ulrich and Schuchert, *T. niagarensis* Hall and Clarke, and *Orthis insularis* Eichwald.

¹ Bull. Denison Univ., 14, p. 82, Pl. 3, figs. 39, 42, Pl. 4, fig. 70, Apr. 1909.

Genus, *CLITAMBONITES* Pander.

Clitambonites trentonensis sp. nov.

Plate VIII, figures 6, 7.

Clitambonites diversa Winchell and Schuchert, Pal. Minn., vol. 3, pt. 1, 1893, p. 378, Pl. 30, figs. 11-17.

Clitambonites americanus Hall and Clarke, Pal. New York, vol. 3, pt. 1, 1892, p. 239, Pl. 15A, figs. 1-4, 7, 8. (Not 5, 6.)

The well-known *Clitambonites* of the Trenton of Ontario and Minnesota seems still to be without a name. Realizing that it was probably distinct from the Richmondian species from Anticosti, authors have lately been referring to it as *Clitambonites americanus*, under the impression that Whitfield's specimens were from the Trenton. Bassler has, however, recently stated that *C. americanus* is from the Richmond.¹

In any case, the specimen figured by Whitfield is of quite a different shape from the majority of the specimens found in the Trenton at Ottawa, and very like *C. diversus* from Anticosti.

In *Clitambonites trentonensis* the greatest width is at the hinge, the shell is appreciably wider than long, the cardinal area of the pedicle valve is high, flat, curved, or twisted, the pedicle shell symmetrical or distorted, the brachial valve gently convex or flat. The surface is marked by coarse, radial striæ which increase both by implantation and bifurcation.

The species differs from *C. diversus* and *C. americanus* in being much wider and of smaller size. From *C. multistriatus* Foerste² it differs in having coarser striæ and a more extended hinge. From *Clitambonites rogersensis* Foerste it may be distinguished, according to Foerste, by having longer muscle-scars in the brachial valve, and, judging from his figures, by the more extended hinge.

Locality. Fairly common in the middle Trenton around Ottawa and in central Ontario. It also occurs in Minnesota, where one stratum characterized by it is known as the *Clitambonites* bed.

Clitambonites ruedemanni sp. nov.

Clitambonites americanus Ruedemann, Bull. New York State Mus., 162, 1912, p. 94, Pl. 4, figs. 14-19.

The specimens from the Snake Hill beds of eastern New York were identified by Foerste with *Clitambonites americanus*, but they differ very markedly from that species and also from *C. trentonensis*

¹ U.S. Nat. Mus. Bull. 92, 1915, p. 244.

² Bull. Sc. Lab., Denison Univ., vol. XVII, 1912, p. 131, Pl. 10, fig. 12.

in having the width at the hinge less than the greatest width and in having a much higher cardinal area. The deltidium is also narrower. The most nearly allied form seems to be *Clitambonites altissimus* Winchell and Schuchert, a shell that has, however, a much wider deltidium.

Genus, ZYGOSPIRA Hall.

Zygospira uphami Winchell and Schuchert.

Plate VIII, Figures 1-5.

Zygospira uphami Winchell and Schuchert. Am. Geol. 9, p. 291, Pal. Minn., 3, pt. 1, p. 468, Pl. 34, figs. 45-48.

This species has not been identified previously outside of Minnesota. It is so large and convex that it suggests *Catazyga*.

Description. Shell large for the genus, transversely oval in outline, strongly bi-convex, with a low fold on the pedicle and a broad, shallow sinus in the brachial valve. Surface covered with fine radial plications, of which there are twenty-seven to thirty on each valve of a large specimen and about twenty on a small one. One large individual (12 mm. wide) has seven plications in the sinus and ten on each side on the brachial valve, and a small one (7 mm. wide) has six in the sinus and seven on each side of it. The smallest specimen seen (5 mm. wide) has four in the sinus and six on each side. The usual number in the sinus among adults is six.

The largest specimen is 10 mm. (estimated) long, 12 mm. wide, and 7.5 mm. thick; an average one is 9.5 mm. long, 11 mm. wide, and 7 mm. thick; the smallest is 5 mm. long, 5 mm. wide, and 2.5 mm. thick.

Horizon and Locality. Found 20 feet below the top of the Prosser limestone (*Fusispira* beds) near Spring Valley, Wykoff, and Fountain, Minn. In Ontario, fairly abundant in the lower part of the Collingwood at Craighleith, Grey county, where it was collected by E. J. Whittaker and the writer.

Class, GASTROPODA.

Genus, HORMOTOMA Salter.

Hormotoma trentonensis Ulrich and Scofield.

Plate VIII, figures 10, 11.

Murchisonia bellicincta Hall, *partim*. Pal. New York, vol. 1, 1847, Pl. 39, fig. 1e.

Hormotoma trentonensis Ulrich and Scofield. Pal. Minn., vol. 3, pt. 2, 1897, p. 1017, Pl. 70, figs. 13, 14.

For further references see Bassler. Bull. 92, U.S. Nat. Mus., 1915, p. 648.

This species is important, as it is one of the most common and conspicuous fossils of the Cobourg formation. Though not confined to that part of the Trenton, it is most common there, and its presence should always lead to a search for other species indicative of the upper Trenton.

Genus, FUSISPIRA Hall.

Fusispira nobilis Ulrich and Scofield.

Plate VIII, Figure 12.

Fusispira nobilis Ulrich and Scofield. Pal. Minn., vol. 3, pt. 2, 1897, p. 1078, Pl. 80, figs. 2-4. Schuchert, Proc. U.S. Nat. Mus., vol. XXII, 1900, p. 168.

This species is very characteristic of the upper Cobourg, and is especially common along the southern edge of the outcrop of the Trenton in Prince Edward county, Ont. Originally described from Minnesota, it has only recently been reported from the more eastern exposures, but is also found in New York.

Genus, PTEROTHECA Salter.

Pterotheca angusta sp. nov.

Plate VIII, figure 8.

It is proposed to designate by this name a small *Pterotheca* which Mr. Whittaker and the writer collected from the highest layers of the Cobourg at Collingwood. It is peculiar in having a sharply angular, median ridge and in the narrowness of the internal platform, the lines bounding it converging at an angle of about 60 degrees, whereas in other species observed by the writer, that angle approximates 90 degrees. The specimen shows no sort of surface markings, beyond the usual longitudinal ridges, a very high, sharply angular median one, with two low gently convex ones bounding it.

The length is 16 mm., and the width is estimated to have been about the same.

Class, Trilobita Walch.

Genus, EOHARPES Raymond.

Eoharpes Ottawaënsis (Billings).

Plate IX, figure 1.

Harpes Ottawaënsis Billings. Pal. Foss. Can., 1865, p. 182, fig. 165.

For further references see Bassler, Bull. 92, U.S. Nat. Mus., 1915, p. 488.

A photograph of the type of this species was published in an earlier number of the Bulletin of the Victoria Memorial Museum, but

the reproduction was unsatisfactory, and is, therefore, reprinted. The specimen is of interest, not only because it is the type, but because it illustrates the ready separation of the upper and lower layers of the fringe. A considerable number of localities for this species are now known, but well-preserved specimens remain rare, and the writer has seen none equal to the type, which was in the collection of Sir James Grant, and was presented by him to the Victoria Memorial Museum. It was found in the upper part of the middle Trenton at Ottawa, Ont.

Eoharpes dentoni (Billings).

Plate IX, figure 6.

Harpes dentoni Billings, 1863. Can. Nat. and Geol., vol. VIII, p. 36, fig., 1865. Pal. Foss., Can. vol. I, p. 183, fig. 166. Raymond, Bull. Vic. Mem. Mus. I, 1913, p. 33, Pl. III, fig. 5.

This species was described by Billings from an incomplete cranium. There is, however, in the collection, a complete but rather poorly-preserved specimen of the same species collected by A. R. C. Selwyn, in 1880. This is the only entire American *Harpes* of which the writer has knowledge.

There do not appear to be more than about eighteen segments in the thorax, and possibly only sixteen, but the specimen is rather obscure in this region, and it is not possible to tell where the pygidium begins. The genal spines are narrow, and so long as to extend slightly beyond the pygidium. They are much longer and the brim is narrower than in *Eoharpes ottawaënsis* (see Plate IX, figure 1). In front of the glabella, the brim of *E. dentoni* is narrow, deeply concave, and the anterior rim is curved upward, whereas in *E. ottawaënsis* the brim at the front is wide and nearly flat. The pair of furrows in front of the posterior oblique pair on the glabella are much stronger in both species than is indicated in the original figures.

A second specimen of this species, found on a tablet, labelled *Dalmanites bebryx*, shows the pygidium and some of the thoracic segments, but here, too, it is impossible to say how much is pygidium. Barrande states that there are three or four segments in the pygidium of *Harpes*, and this fragment exhibits fifteen segments in all. It is from a much larger individual than the one collected by Selwyn, and evidently when complete had more segments. The genal spines extend beyond the pygidium.

Locality. Ottawa, Ont. Label reads "Ottawa river," and is, therefore, presumably from the "Cystid zone" (upper part of middle Trenton).

Genus, REMOPLEURIDES Portlock.

Remopleurides striatulus Walcott.

Plate IX, figure 7.

Remopleurides striatulus Walcott. Cin. Quart. Jour. Sc., 2, 1875, p. 347, fig. 27A, a,b.

An hypostoma of this exceedingly rare trilobite is figured merely to call attention to a new locality for the species. The specimen is 13 mm. long and 6 mm. broad at the widest point. The prongs are 9 mm. long, and each shows two strong longitudinal striations, with one or two subordinate ones at the proximal end. The type has more numerous striations.

Horizon and Locality. Found by E. J. Whittaker in the Prasporea zone at Trenton, Ont. At least one cranidium of this species has been found at Governor bay, near Ottawa.

Genus, BATHYURUS Billings.

Bathyurus ingalli Raymond.

Plate IX, figures 3-5.

Bathyurus ingalli Raymond, Bull. Vic. Mem. Mus. 1, p. 57, Pl. VII, fig. 7, 1913.

Only the cranidium was known at the time this species was described. Since then Mr. Whittaker has fortunately discovered a pygidium and a free cheek at the type-locality.

The pygidium proves to be very similar to that of *B. spiniger*. It is small, short, and highly convex, with a long, erect, stout spine which curves backward. This spine arises somewhat farther back than the one on *B. spiniger*; there are two rings on the axial lobe in front of it, before reaching the articulating half-ring, instead of only one as in *B. spiniger*. The pleural lobes show four pairs of rounded ribs and the border is narrow, smooth, and concave, faintly marked by the ribs as in most species of *Bathyurus*.

The free cheek figured, which is really only the impression of the exterior of the left cheek, seen from the inside, is broad with a wide concave genal spine. There are slight traces of pustules just outside the eye, but there does not seem to be so large a patch as is present in this position in *B. spiniger*.

The pygidium is 7 mm. long and 16 mm. wide at the front, but is somewhat shortened by crushing. The spine is 9 mm. long and

2.5 mm. thick at the base. The free cheek is 22 mm. long, from back of neck-ring to front across eye, and the spine extends 25 mm. back of nuchal segment. From inner posterior angle of eye to outer margin, on a line perpendicular to the axis of the trilobite, the cheek is 15 mm. wide.

With the additional knowledge afforded by these specimens it may still be said that *Bathyrurus ingalli* is closely related to *B. spiniger*, but differs from that species in its larger size, much larger spine on the neck ring, wider border on cranidium and free cheeks, wider and less pustulose free cheeks, wider pygidium, and a more posterior position of the spine on that shield.

Horizon and Locality. Common in the "crinoid beds" at the liftlock at Kirkfield, and rare at the same horizon near Bellevue and Ottawa. Specimens collected by W. A. Johnston, E. J. Whittaker, and the writer.

Genus, *GOLDIUS* de Koninck.

Goldius lunatus (Billings).

Plate IX, figure 8.

Bronteus lunatus Billings. Geol. Surv., Can., Rept. of Prog., for 1853-56, 1857, p. 338. Geology of Canada, 1863, p. 188, fig. 187. For further references see Bassler, Bull. 92, U.S. Nat. Mus., 1915, p. 559.

This still remains a rare fossil, but Billings' figure is so often reproduced that it has been deemed advisable to include a photograph of one of the cotypes, which is not so well preserved as would be suggested by the illustration in the "Geology of Canada, 1863." Enough specimens are known, however, to justify the restoration.

The type is from the upper part of the middle Trenton along the Ottawa river, at Ottawa.

Genus, *HEMIARGES* Gürich.

Hemiarges paulianus (Clarke).

Plate IX, figure 2.

Arges wesenbergensis var. *paulianus* Clarke, Pal. Minn., 3, Pl. 2, 1894, p. 744, figs. 62-64.

This is a small and rare trilobite, which has not been well figured. The illustration is of a fairly well-preserved cranidium collected by Mr. Whittaker near the liftlock at Kirkfield.

Description. Cranidium small, broader than long, the surface covered with relatively large pustules. Glabella divided into five lobes,

a narrow central one which does not expand rapidly forward, a pair of large anterior side lobes, and a small posterior pair. The posterior pair of glabellar furrows are deeply impressed, and joining the dorsal furrows, strongly isolate the anterior pair of lobes. Posterior lobes not strongly separated either from the central lobe, or the mounds bearing the palpebral lobes. Neck furrow deep, producing a distinct and narrow occipital segment. There is no pair of basal lobes back of the eye-mounds.

Length of figured specimen, 5 mm., width between eyes 1.5 mm.

This species is certainly very like the Russian form with which Dr. Clarke identified it. *Hemiarges wesenbergensis*, has, however, somewhat less isolated anterior side lobes, and shorter marginal spines on the pygidium, as Dr. Clarke has already pointed out.

Güirich's subgeneric name *Hemiarges* may well be adopted for this species, which lacks the basal lobes of a typical *Trochurus*, though there is a suggestion of them in Schmidt's figure of the Russian form. No trace of them is seen on American specimens.

Horizon and Locality. Mr. J. E. Narraway has found this species in the Crinoid beds in Hull, Que., and the figured specimen is from loose material at the Kirkfield liftlock, either from the Dalmanella beds or the Crinoid beds. In Minnesota, it has been found in the Prosser limestone at St. Paul and Wykoff. Weller found a species of the same genus, *Hemiarges tuberculatus* (Weller), in the Black River near Iliffs Pond, New Jersey.

Genus, ENCRINURUS Emmrich.

Encrinurus cybeleformis sp. nov.

Plate XI, figure 2.

Known from pygidia only. Pygidium narrowly triangular in outline, strongly convex, with long, narrow, axial lobe which is very low at the posterior end but is distinctly outlined. Pleural lobes curved sharply downward, and marked by nine pairs of rounded ribs, not ornamented with tubercles. Anterior end of axial lobe crossed by three sharp rings, and back of the third ring is a wide, smooth area along the median portion. At the sides of this area about fifteen or sixteen pairs of incomplete rings are interrupted by the smooth band, and extend to within about 2 mm. of the posterior end, where the whole lobe becomes smooth. There is a median tubercle on the third ring, another where the sixth would have crossed, and faint traces of tubercles where the ninth and thirteenth should cross.

Length of holotype, 8.5 mm., width at front, 7.5 mm.

Six species of *Encrinurus* have been described from the Trenton. Two of these, *E. varicostatus* Walcott and *E. vannulus* Clarke, have only six pairs of ribs on the pleural lobes, and one, *E. rarus* (Walcott), is known from the glabella only, unless this species be identical with *E. vannulus*. *Encrinurus vigilans* (Hall) has nine pairs of ribs on the pleural lobes, but it is said that alternate pairs show tubercles. The axial lobe of this species is reported to have eighteen rings which are represented in the figures as uninterrupted, and there is nothing in the description to indicate the contrary. Likewise, the median lobe is said to have tubercles on every third or fourth ring. In the figure, tubercles are seen on the first, third, sixth, ninth, and twelfth rings. *Encrinurus trentonensis* Walcott is a little more like the present species. It also has nine pairs of ribs on the pleural lobes, and has twenty-three rings on the axial lobe, and behind them other rings too indistinct to be counted. Weller states that in specimens of this species from New Jersey, the rings between those bearing tubercles become faint and even almost obsolete in the middle. Walcott mentions nodes on the first, third, sixth, tenth, fourteenth, eighteenth, and twenty-second rings of this species, and Weller noted them on the first, fourth, seventh, eleventh, and nineteenth rings.

From this resumé it may be seen that *E. cybeleformis* differs from its closest allies, *E. trentonensis* and *E. vigilans*, in having the rings of the axial lobe obscured along the top of the lobe by a smooth band, in the great reduction of tubercles on the axial lobe, and their absence from the pleural lobes. *E. tuberculosus* Collie need not be compared in any detail, as it bears tubercles in every possible place.

Horizon and Locality. From the Dalmanella beds of the Trenton west of the Kirkfield liftlock, where the type was collected by E. J. Whittaker.

Genus, CYBELE Lovén.

Cybele spicata sp. nov.

Plate XI, figure 1.

This species is known only from a single, imperfect cranidium, but as it is the only true Cybele so far found in America, it is worth describing.

Glabella moderately convex, its outline concave at the sides, expanding forward. Sides indented by three pairs of short but deep glabellar furrows which have the form of transverse pits connected by a shallow depression with the dorsal furrow, and their inner ends running as shallow furrows up into the more convex median part of the glabella. At the anterior margin of the glabella is a narrow furrow, in front

of which rise five large spines, all broken off at the base on this specimen. Along the top of the glabella is a row of pairs of sharply conical pustules. The fixed cheek is wide and does not extend far forward, the eye situated on a small mound (but broken away) and rather far back for this genus. Genal angle apparently rounded, though it may have borne a spine.

Length about 6 mm., width about 20 mm.

This species is exceedingly like *Cybele coronata* Schmidt, from the Kuckers of Esthonia, Russia.¹ Otherwise, it might be mistaken for an *Encrinurus*. The five stout spines at the frontal margin are, of course, the striking feature. It is hoped that better specimens will fall to the lot of some collector. All of the other so-called *Cybeles* in America have a peculiar tripartite glabella instead of a normal one with lateral furrows. All the American forms have, therefore, been transferred to *Cybeloides*, a genus erected for them by Slocum. The present species agrees in glabellar structure with many of the European forms referred to *Cybele*, though not strictly in accord with the genotype, *C. bellulata*.

Horizon and Locality. The specimen is from the lower part of the Collingwood limestone at Craigleith, Ont., and was collected by E. J. Whittaker.

Genus, *CERAURUS* Green.

Ceraurus dentatus Raymond and Barton.

Plates X, XI, figures 7, 8.

Ceraurus dentatus Raymond and Barton, Bull. Mus. Comp. Zoöl., 54, No. 20, 1913, p. 534, Pl. 1, fig. 1, Pl. 2, figs. 4, 5.

Ceraurus pleurexanthemus Hall (partim), Pal. N.Y. 1847, 1, Pl. 65, figs. 1d, 1h, 1i, 1m; Pl. 66, figs. 1a-1g. Emmons, Geol. Sec. Dist. New York, 1842, p. 390, fig. 6; Am. Geol. 1855, 1, Pl. 15, figs. 1a, 1f, 1h, 1i, 1k. Billings, Geol. Can., 1863, p. 188, fig. 188. Cumings, 32d Ann. Rept. Indiana State Geol. Surv., 1908, Pl. 54, figs. 9-9b (after Hall).

The larger specimens figured by Hall differ from the typical form of *Ceraurus pleurexanthemus* in having the eyes much farther back and without eye-lines, in the possession of much longer and less divergent genal spines, and in having two pairs of well-developed spines on the pygidium, within the great spines.

¹ Mem. de l'Imp. Acad. d. Sc., Ser. 7, 30, No. 1, 1881, p. 213, Pl. 13, figs. 24-27; Pl. 14, fig. 5; Pl. 15, fig. 10.

These characteristics might seem merely the accompaniments of the greater size attained by the specimens, but that such is not the case is shown by the fact that there are specimens of *C. dentatus* in Canada which are smaller than the large specimens of *C. pleurexanthemus* from Trenton Falls. And, furthermore, series of specimens from Trenton Falls show that there is no backward movement of the eye or increase in the length of the genal spines with increase of size.

It is rather peculiar that the only good figure ascribed by the earlier writers to *Ceraurus pleurexanthemus* should prove to belong to this species. The illustration referred to is the one given by Billings in the Geology of Canada, 1863. The Victoria Museum does not contain any specimen as perfect as is indicated by this figure, and it is, very probably, a composite illustration. The general form, the cephalon, and pygidium appear to have been drawn from specimen No. 1775, which was selected as the holotype of *Ceraurus dentatus*, whereas the thorax and ornamentation were apparently drawn from specimen No. 1769. The sharp pustules on the posterior border of the cephalon especially are very like those on that individual. The figure is less than half the size of No. 1775, but is almost exactly one-half the size of a third specimen, No. 1769b.

Another well-known example of this species is the large specimen figured by Hall on Plate 66 of the Palæontology of New York, 1. This specimen, said by Hall to have come from "near Cincinnati, Ohio," is entirely unlike any which has been found in that vicinity since, and is very similar to those found in New York and Canada. An examination of this individual in the American Museum of Natural History, New York, shows that the lithology is very unlike the yellow-weathering rock of the Cincinnati region, and, moreover, it is labelled as coming from Middleville, N.Y.

This species contains the largest specimens of *Ceraurus* now known. The largest is in the Victoria Museum and was collected by the late H. G. Vennor at Belleville, Ont. It must have been, when complete, over 100 mm. long and 85 mm. wide—a veritable giant, when compared with the average specimen of *Ceraurus pleurexanthemus* from Trenton Falls, being nearly double the length of the largest found there. The spines on the pygidium grow to great length. Those on the type, which is 84 mm. in length, are 27 mm. long, and several had longer ones. The spines on a pygidium collected by the writer near the base of the Trenton at Healy falls, Trent river, Ont., are 38 mm. long.

Measurements. The holotype is 84 mm. long, 60 mm. wide at the genal angles, the cephalon is 24 mm. long, the glabella 17.5 mm.

wide at the front and 15.5 wide at the neck-ring. A somewhat smaller specimen from Cobourg, Ont., is 74 mm. long, 54 mm. wide at the genal angles; the cephalon is 22.5 mm. long, the glabella is 17.5 mm. wide at the front and 13.5 wide at the neck-ring.

Horizon and Locality. This species, so far as is known, confined to the Trenton, seems to be found all through that formation, although especially common in the lower part. It occurs at the following localities, and will probably be found at numerous other places, especially in the Central States: Middleville, N.Y. (exact horizon not known); Roaring Run, East Martinsburg, N.Y. (in strata corresponding to the Crinoid beds of the Ontario section); and in Ontario at Belleville (Crinoid beds); Cobourg (Sponge beds at top of Trenton); Healy falls (Dalmanella beds at base of Trenton); Trenton and Peterborough (Prasopora beds); Fenelon Falls and Kirkfield (Crinoid beds, very common). The type was collected at Vankleek Hill, east of Ottawa, by Logan, but the exact horizon is not known.

Genus, CERAURINUS Barton.

Ceraurinus marginatus Barton.

Plate XI, figure 6.

Ceraurinus marginatus Barton, Bull. Mus. Comp. Zoöl., 54, No. 21, 1913, p. 550, Pl. —, fig. 1.

A cranidium which appears to belong to this species was found in the Collingwood at Craigleith. It is much smaller than the type, but has a similar border in front of the glabella, a short frontal lobe, rectangular glabella decreasing slightly in width at the front, and sharp glabellar furrows.

The length is 11 mm., the width 23 mm.

The specimen cannot be identified with either *Ceraurinus scofieldi* (Clarke) or *C. trentonensis* Barton because the glabella does not expand forward. It differs from *C. icarus* (Meek) in not having the basal lobes isolated. The partial coalescence of the posterior right glabellar lobe with the one in front of it suggests *C. confluens* Barton, but there is not so complete coalescence as in that species, the frontal lobe is shorter, and the basal lobes narrower.

The finding of this specimen in the Collingwood suggests that the original specimen of *C. marginatus* may have come from that formation. The type is without label as to locality other than "Ontario," and the colour of the matrix is very like that of the specimen here described.

Horizon and Locality. From the lower part of the Collingwood limestone at Craigleith. Collected by E. J. Whittaker.

Genus, CALYMENE Brongniart.

Calymene sp. ind.

Plate XI, figure 5.

This very young individual of an undetermined species of *Calymene* from the soft, light-coloured shale above the Collingwood at Craigleith, is figured to call attention to an important feature in the development of this genus. The facial sutures in the adult cut the genal angles exactly as they do in *Triarthrus*, making it difficult to determine from this characteristic alone whether the genus should be referred to the Opisthoparia or Proparia. In the development, however, as shown by young specimens, the cheeks are first decidedly Proparian, and the posterior portion of the facial suture reaches the margin in front of the genal angle.

Genus, PTERYGOMETOPUS Schmidt.

Pterygometopus achates (Billings).

Plate XI, figure 3.

Dalmanites achates Billings. Can. Nat. and Geol., vol. V, 1860, p. 63, fig. 9. For further references see Bassler, Bull. 92, U.S. Nat. Mus., 1915, p. 1065.

This species, characterized by the broadly oval frontal lobe of the glabella, was described originally from the middle Trenton, but seems to have a considerable vertical range. It is one of the most common species in the Kimmswick of Missouri (lower Trenton), but the specimen figured is from the Cobourg (upper Trenton) at Picton, Ont.

PLATE I.

Lebetodiscus dicksoni (Billings). (Page 5.)

The specimen collected by Sir James Grant at Ottawa, Ont. From the upper part of the middle Trenton. Enlarged $3\frac{1}{2}$ diameters. No. 437.

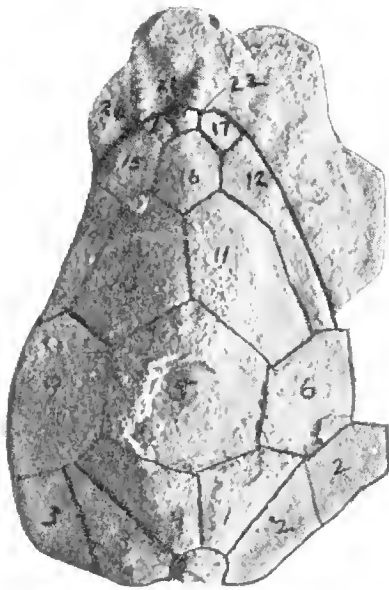


PLATE II.

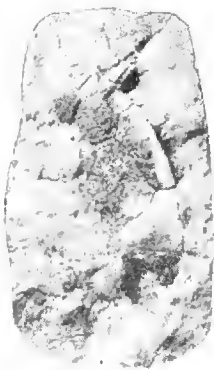
- FIGURE 1. *Pleurocystites laevis* (Raymond). (Page 2).
The type, from the Hull formation at Kirkfield liftlock, Ont. Natural size. No. 7936.
- FIGURE 2. The same specimen, with the sutures inked and the plates numbered.
- FIGURE 3. The same species. Another specimen, to show the true form of Plate XII. Same locality. One-third less than natural size. No. 3248.
- FIGURE 4. *Amygdalocystites florealis* Billings. (Page 3.)
A specimen from the Hull formation at Kirkfield liftlock, showing the bases of the arms. One-third less than natural size. No. 3246.
- FIGURE 5. *Amygdalocystites radiatus* Billings. (Page 3.)
A large, rather badly weathered specimen showing the plates of the food groove, and rather faintly the bases of some of the brachioles. One-third larger than natural size. From the Hull formation at Healy falls, Ont. No. 3236b.
- FIGURE 6. The same species. Another specimen from the same locality as the last, showing the anal pyramid especially well. One-third larger than natural size. From the Hull formation at Healy falls, Ont. No. 3236b.
- FIGURE 7. The same species. Another specimen from the same formation and locality, with some of the brachioles well preserved. One-third larger than natural size. No. 3236.
- FIGURE 8. *Carneyella chapmani* (Raymond). (Page 9.)
The holotype. From the middle Trenton at Jackson park, Peterborough, Ont. 2-6 times natural size. No. 3255.
- FIGURE 9. *Lebetodiscus loriformis* Raymond. (Page 7.)
The holotype before cleaning. The specimen is from Trenton (probably middle Trenton) at Ottawa. Twice natural size. No. 1414.



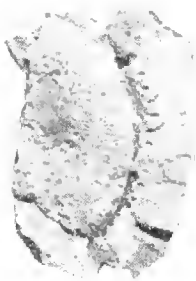
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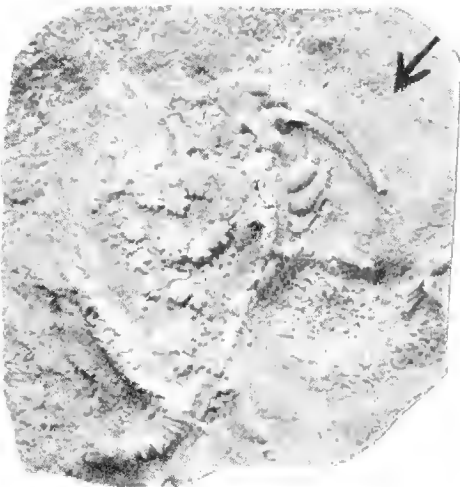
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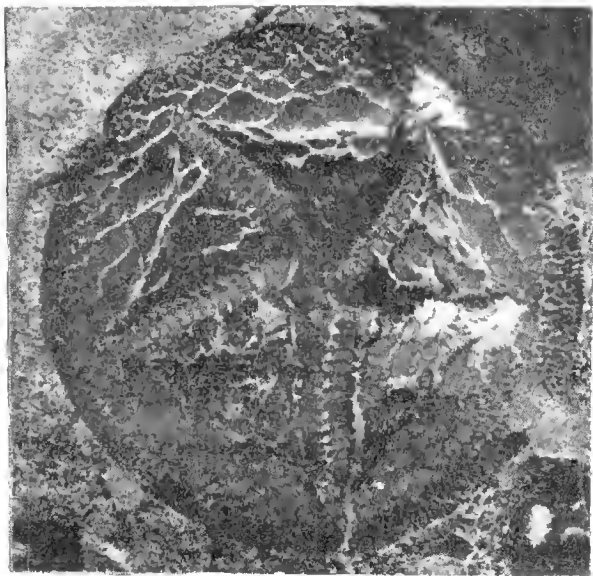
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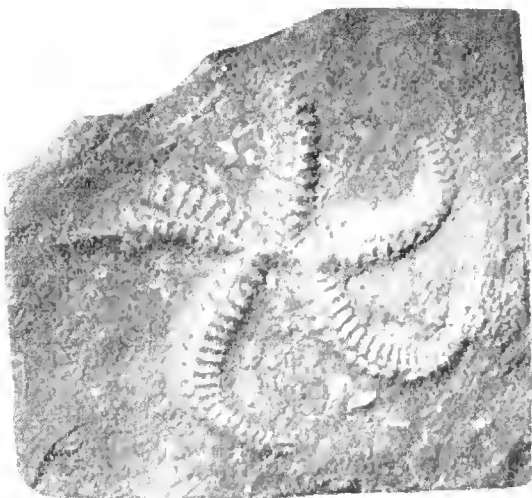
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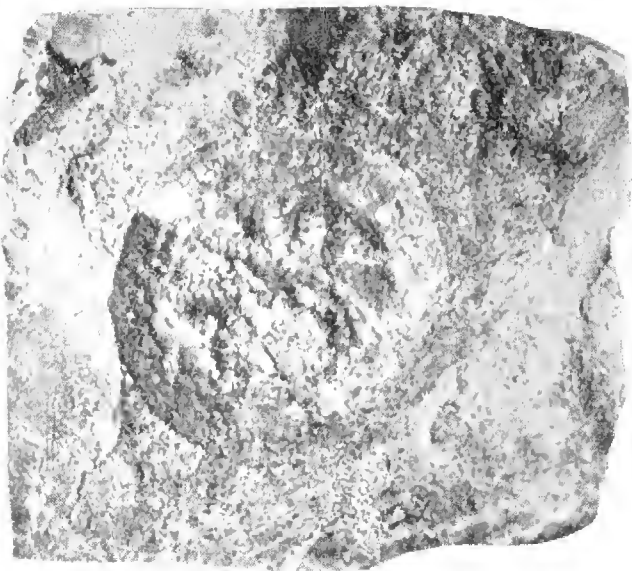
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PLATE III.

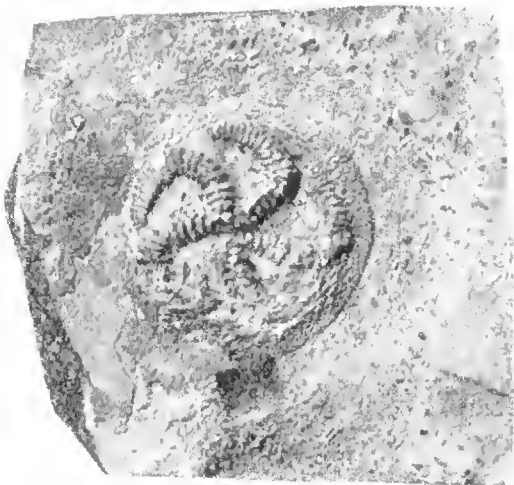
- FIGURE 1. *Lebetodiscus dicksoni* (Billings). (Page 5.)
A specimen from Peterborough, Ont. Probably from the middle Trenton. One-half larger than natural size. No. 1412.
- FIGURE 2. *Lebetodiscus loriformis* Raymond. (Page 7.)
The same specimen shown in figure 9, Plate II, after cleaning with potash. Natural size. No. 1414.
- FIGURE 3. *Carneyella billingsi* (Chapman). (Page 7.)
A specimen from the typical locality, the middle Trenton at Peterborough, Ont. 3.3 times natural size. No. 5393.
- FIGURE 4. *Carneyella youngi* (Raymond). (Page 9.)
The holotype. From the middle Trenton on lot 12, con. I, Eldon tp., Ont. Three times natural size. No. 3234.
- FIGURE 5. *Carneyella multibrachiata* (Raymond). (Page 11.)
The holotype. From the Hull formation at Kirkfield liftlock, Ont. Three times natural size. No. 7789.
- FIGURE 6. *Carneyella chapmani* (Raymond). (Page 9.)
The same specimen shown in figure 8, Plate II. Twice natural size.
- FIGURE 7. *Carneyella platys* (Raymond). (Page 10.)
The holotype. Probably from the middle Trenton. Found at Ottawa, Ont. 1.66 times natural size. No. 7941.



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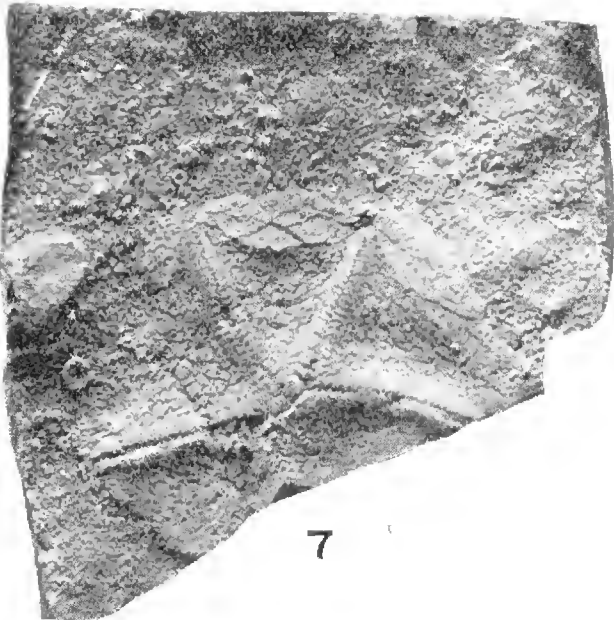
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PLATE IV.

Isorophus inconditus (Raymond). (Page 12.)

Four specimens in their natural position, resting on the sea bottom, showing that they were not attached to shells or other objects. With the decay of the animal the central portion sank in, leaving an elevated row of marginal plates. The largest specimen is the holotype. 3.2 times natural size. No. 1409. From the middle Trenton at Queens wharf, Ottawa, Ont.

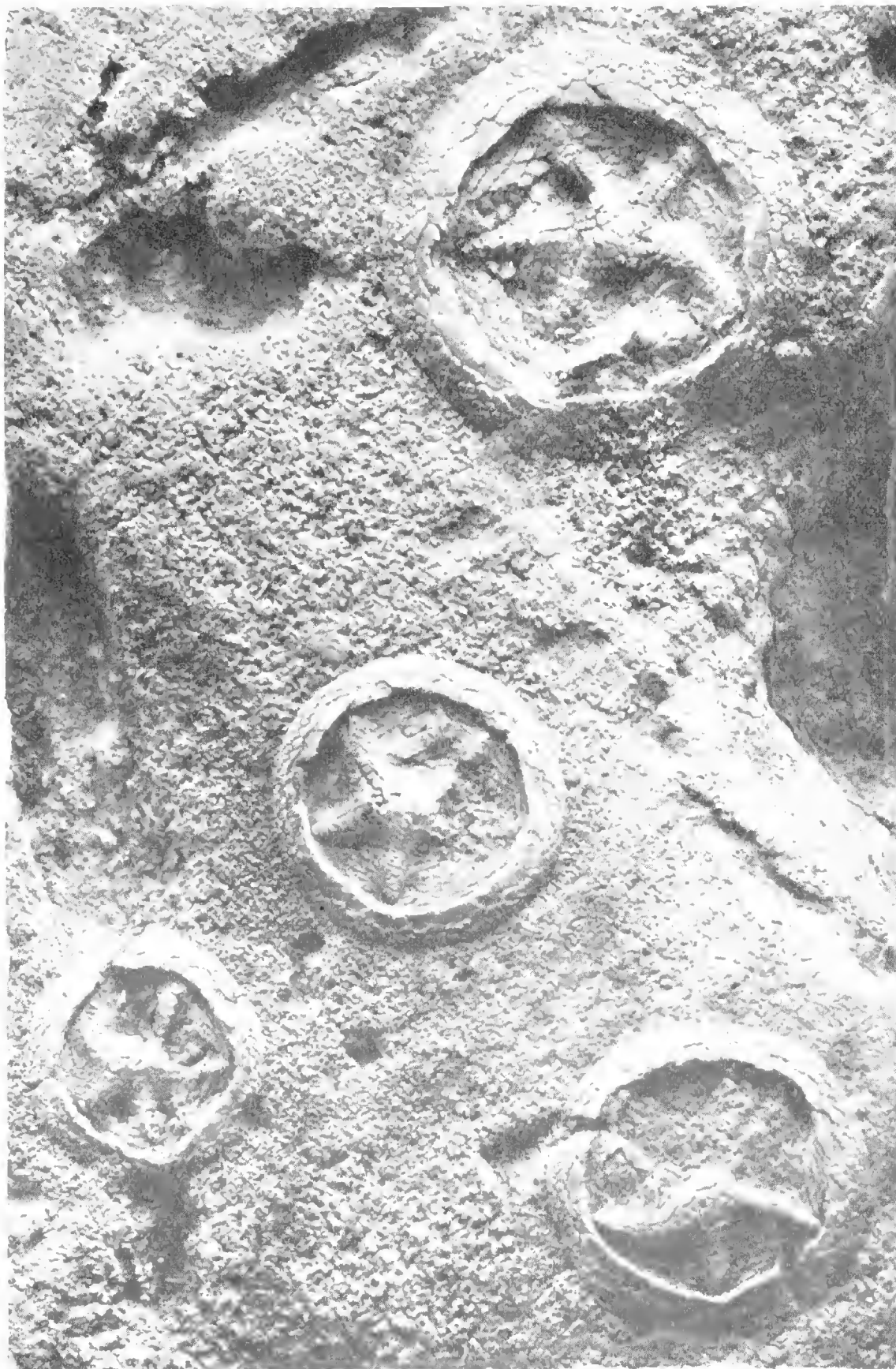


PLATE V.

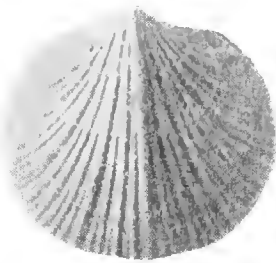
- FIGURES 1, 2. *Pseudolingula iowensis* (Owen). (Page 14.)
Brachial and pedicle valves of a specimen from the upper part of the middle Trenton at Trenton, Ont. Natural size.
- FIGURES 3, 4. *Dalmanella testudinaria* (Dalman). (Page 14.)
From the Trenton at Trenton Falls, N.Y. In the Museum of Comparative Zoölogy, Cambridge, Mass. Twice natural size.
- FIGURES 5, 6. *Dalmanella rogata* (Sardeson). (Page 14.)
From Borenskult, Sweden. No. 3992 in the Museum of Comparative Zoölogy, Cambridge, Mass. Twice natural size.
- FIGURES 7, 8. *Dalmanella resupinata* Raymond. (Page 16.)
A large silicified specimen from Grand island, Balsam lake, Ont. Twice natural size. No. 3241.
- FIGURES 9, 10. A smaller specimen of the same species, from the same locality. Twice natural size. No. 3241a.
- FIGURES 11, 12, 13, 14. *Dalmanella whittakeri* Raymond. (Page 16.)
Four views of two specimens from the middle Trenton at Peterborough, Ont. Twice natural size. Nos. 3240 and 3240a.



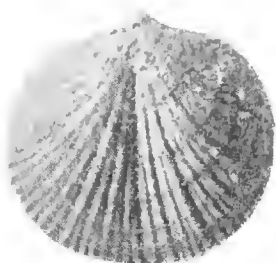
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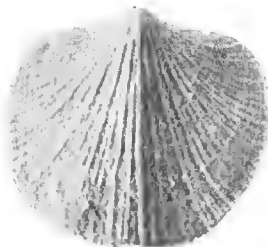
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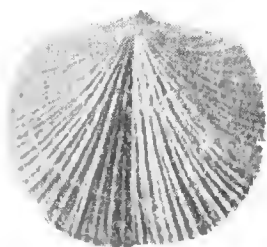
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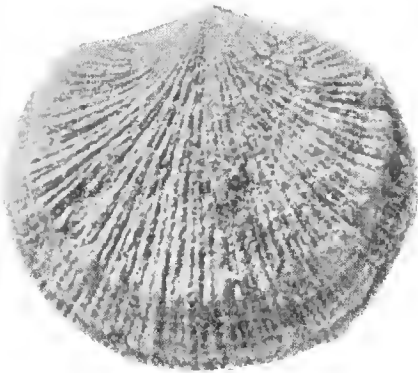
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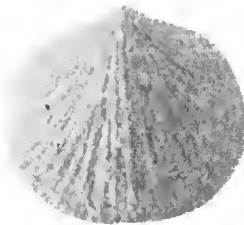
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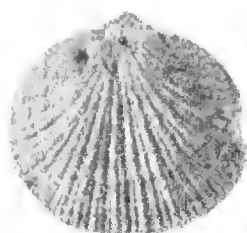
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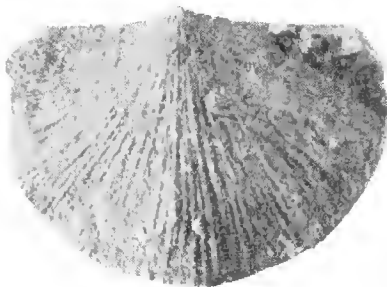
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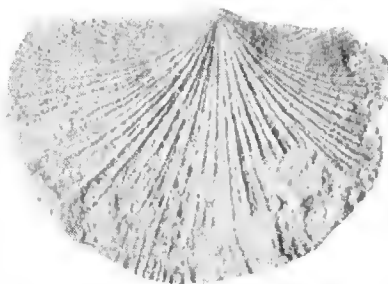
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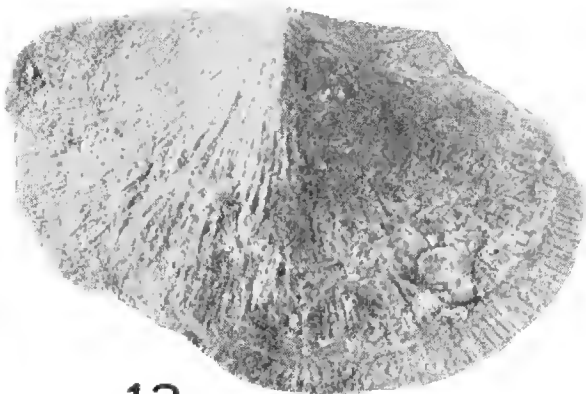
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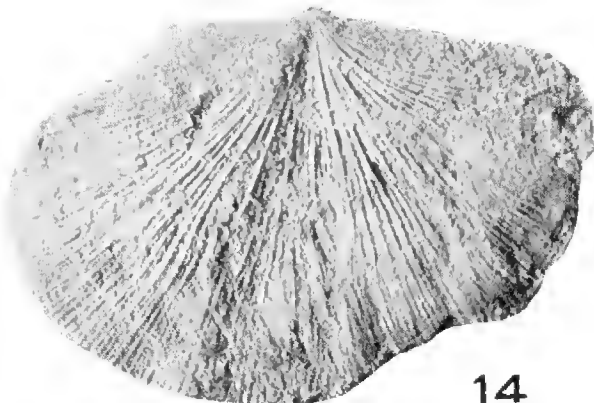
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PLATE VI.

FIGURES 1, 2. *Platystrophia amœna* McEwan. (Page 17.)

Brachial and pedicle valves of a normal, fully adult or slightly senile individual from the Trenton at Trenton Falls, N.Y. Specimen in the Museum of Comparative Zoölogy. Natural size.

FIGURE 3. Interior of the pedicle valve of a large adult, from the same locality and in the same collection as the last. Natural size.

FIGURES 4, 5. The same species. A not quite fully grown specimen from the same locality, and in the same collection. Natural size.

FIGURES 6, 7, 8, 9. *Platystrophia champlainensis* McEwan. (Page 19.)

Four views of a specimen from the lowest Trenton at Montreal, Que. Twice natural size. No. 3243.

FIGURE 10. *Platystrophia minuta* Raymond. (Page 20.)

A fragment of rock with the holotype (brachial valve) and paratype (imperfect pedicle valve) of this species. From the lowest Trenton at Lorette, Que. No. 3242.

FIGURE 11. *Platystrophia amœna* McEwan. (Page 17.)

A large and typical specimen from Ottawa; exact horizon unknown. No. 1628b.

FIGURE 12. *Rafinesquina camerata* (Conrad). (Page 21.)

A single very perfect pedicle valve from the Collingwood at Craigeleith, Ont. Natural size. No. 3256a.

FIGURE 13. The same species. A slab with several exfoliated pedicle valves. From the same formation and locality as the above. Natural size. No. 3256.

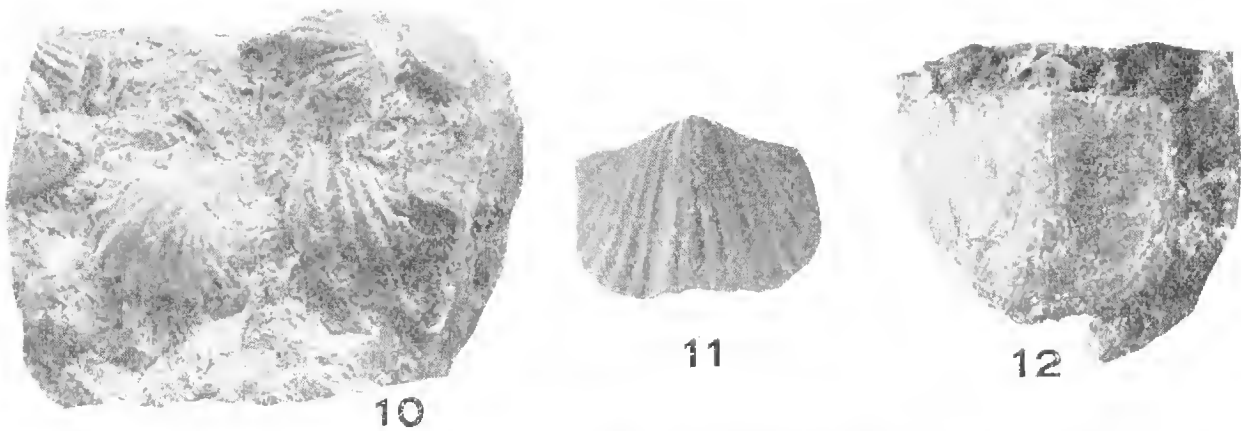
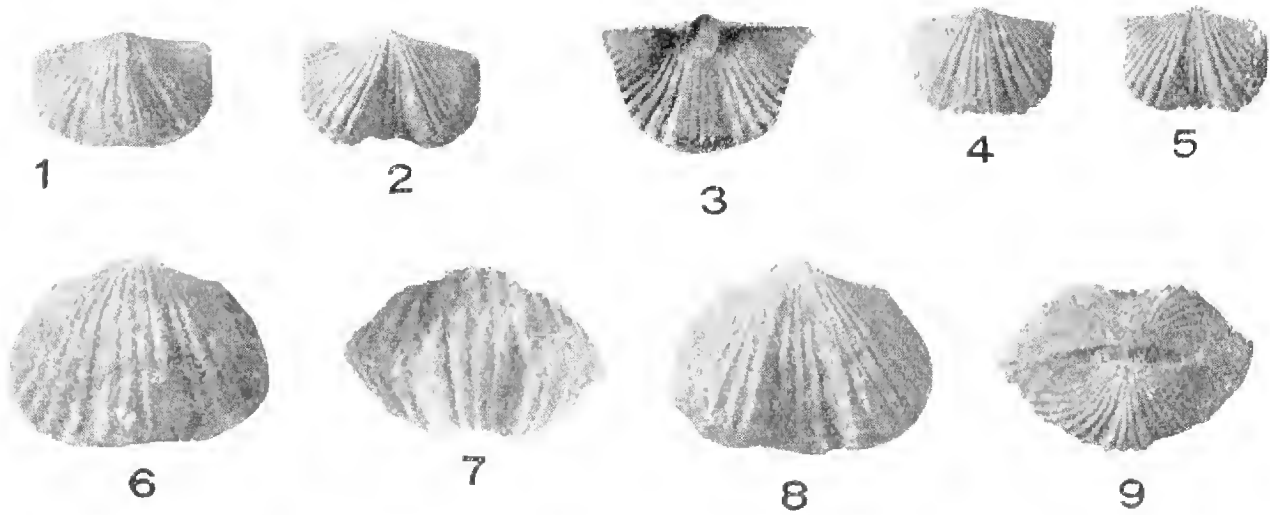


PLATE VII.

- FIGURE 1. *Strophomena winchelli* Hall and Clarke. (Page 24.)
A specimen retaining both valves, viewed from the brachial side. One-half larger than natural size. No. 4382.
- FIGURE 2. *Rafinesquina camerata* (Conrad). (Page 21.)
Interior of a brachial valve, showing muscle-scars and pustulose surface. From the Collingwood at Craigleith, Ont. Natural size. No. 3258.
- FIGURE 3. *Strophomena filitexta* Hall. (Page 24.)
An interior, showing the large muscle-scars. For comparison with *S. trilobata*. No. 1156a.
- FIGURE 4. *Strophomena foveata* (Raymond). (Page 23.)
The brachial valve of the holotype from the middle Trenton at Peterborough, Ont. One-half larger than natural size. No. 3260.
- FIGURE 5. *Rafinesquina praeursor* Raymond. (Page 22.)
A pedicle valve (the holotype) from the upper part of the middle Trenton at Trenton, Ont. One-half larger than natural size. No. 3259.
- FIGURE 6. *Strophomena trilobata* (Owen). (Page 22.)
A slab with two pedicle valves seen from the interior and two brachial valves seen from the exterior. From the Cobourg at Picton, Ont. Natural size. No. 3261.
- FIGURES 7, 8. *Plectambonites youngi* Raymond. (Page 24.)
Opposite views of the holotype, from the lowest Trenton at the "Natural steps" above Montmorency falls, Que. Twice natural size. No. 3250.

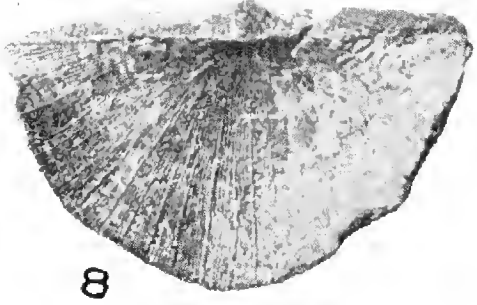
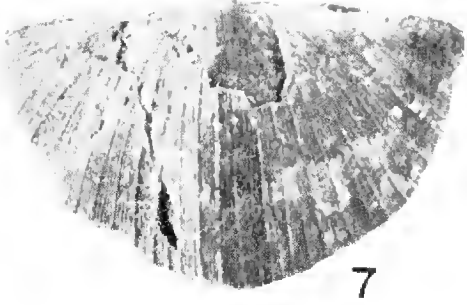
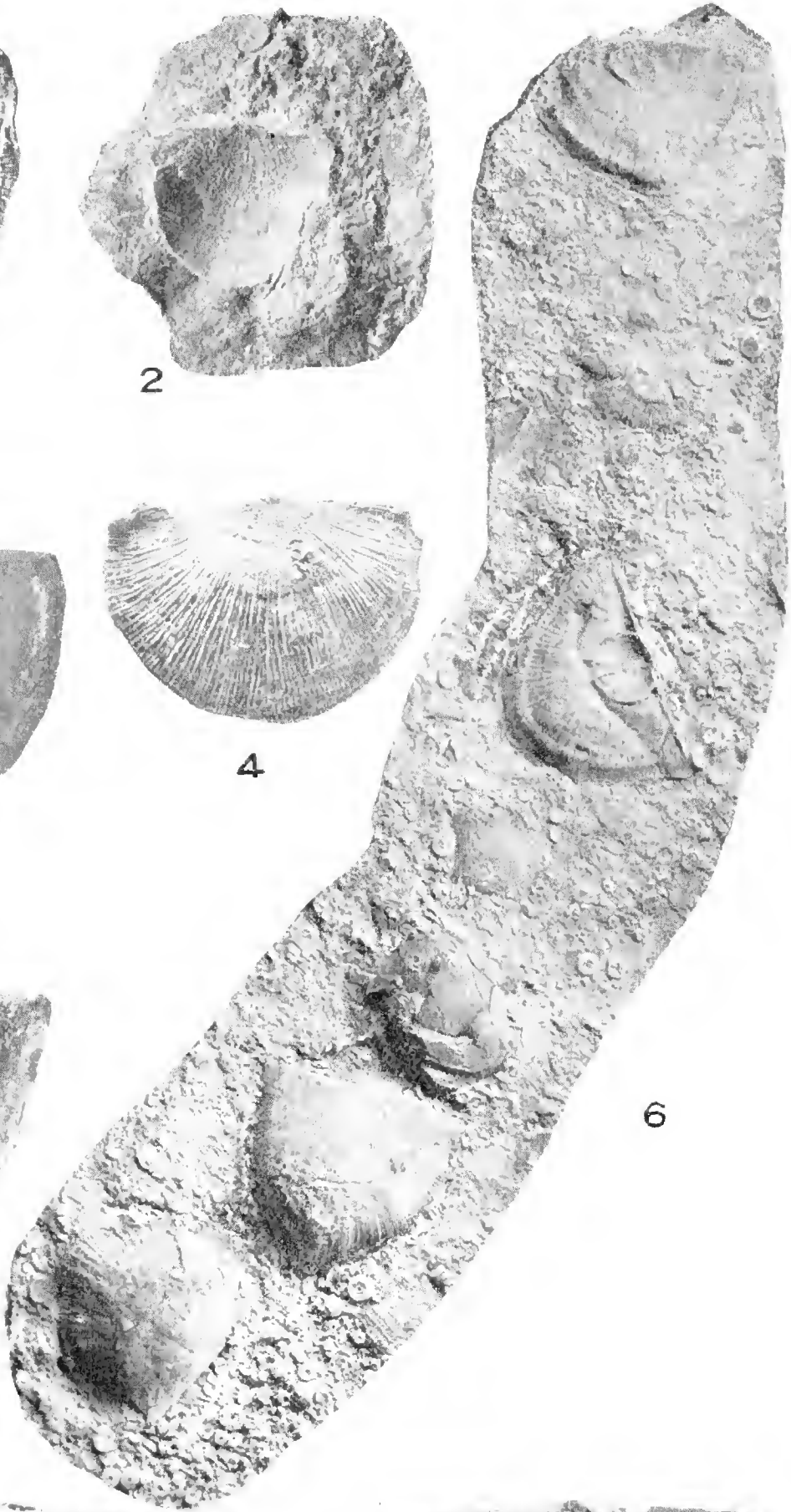
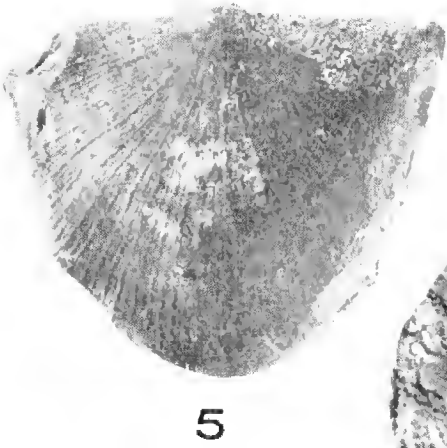
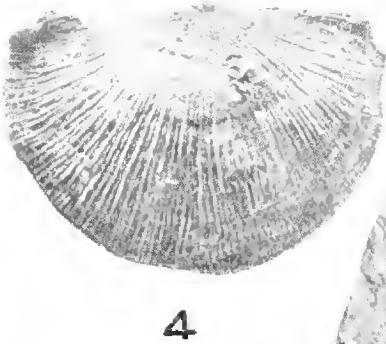
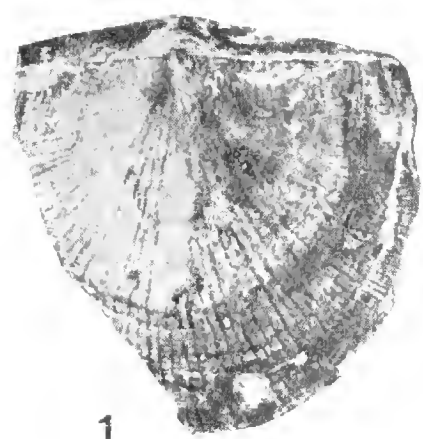


PLATE VIII.

- FIGURES 1-5. *Zygospira uphami* Winchell and Schuchert. (Page 28.)
Five specimens, 1 and 4 seen from the pedicle, and 2, 3, and 5 from the brachial side. All from the Collingwood at Craigleith, Ont. Twice natural size. No. 3245.
- FIGURES 6, 7. *Clitambonites trentonensis* Raymond. (Page 27.)
Pedicle and cardinal views of the holotype. From the middle Trenton at Jessop rapids, Bonnechère river, Ont. Twice natural size. No. 1612b.
- FIGURE 8. *Pterotheca angusta* Raymond. (Page 29.)
The holotype. From the highest Cobourg beds at Collingwood, Ont. Natural size, No. 3266.
- FIGURE 9. *Conularia trentonensis* Hall.
From the Collingwood at Craigleith, Ont. Natural size. No. 3255.
- FIGURE 10. *Hormotoma trentonensis* Ulrich and Scofield. (Page 28.)
From the upper Trenton (Cobourg) at Ottawa, Ont. Natural size. No. 1678f.
- FIGURE 11. The same species. A small specimen retaining some of the surface markings. From the upper Cobourg at Wellington, Ont. No. 3265.
- FIGURE 12. *Fusispira nobilis* Ulrich and Scofield. (Page 29.)
From the upper Cobourg at Wellington, Ont. Natural size. No. 3262.

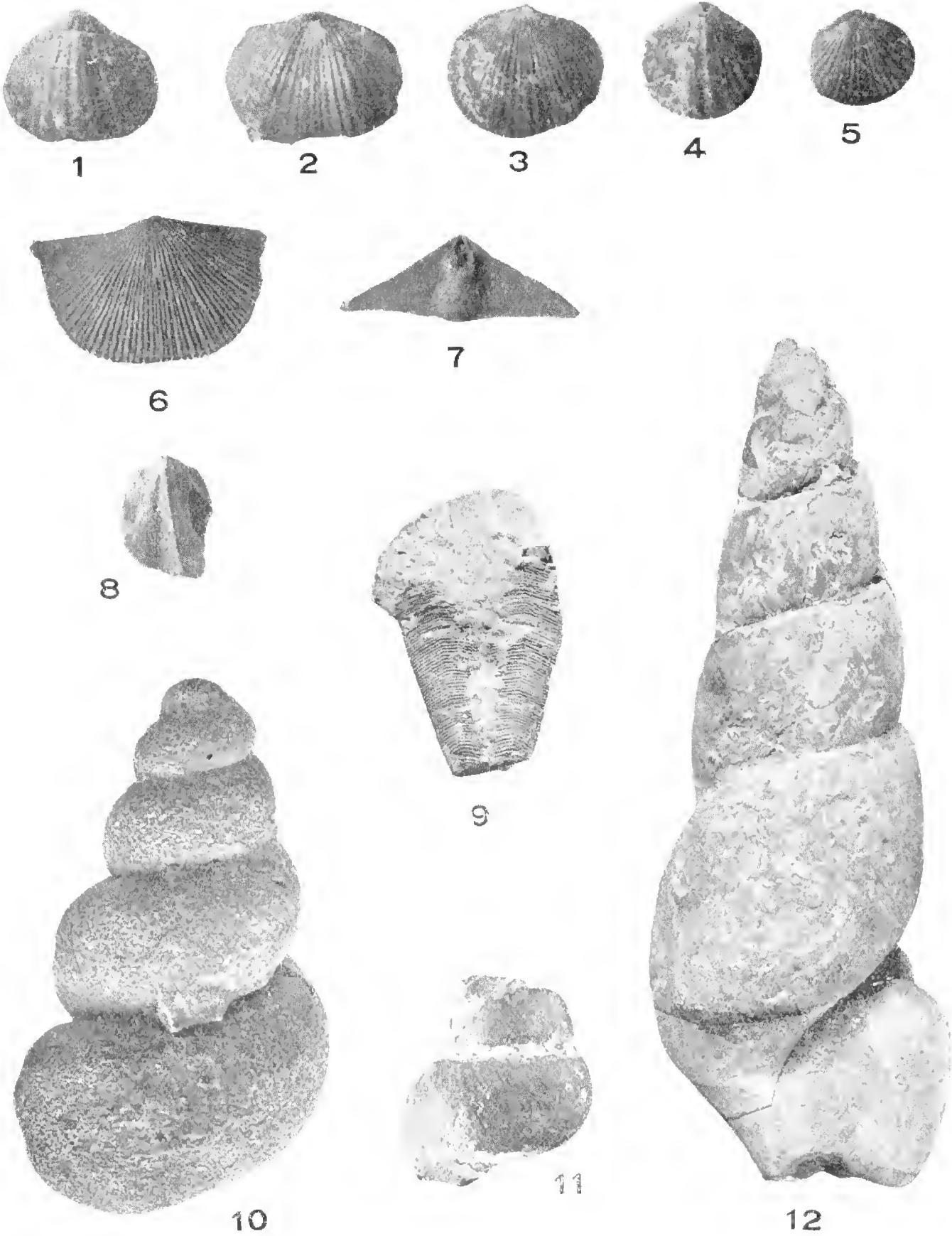


PLATE IX.

- FIGURE 1. *Eoharpes ottawaensis* (Billings). (Page 29.)
The type, presented by Sir James Grant. From the middle Trenton at Ottawa, Ont. 1.37 times natural size. No. 329.
- FIGURE 2. *Hemiarges paulianus* (Clarke). (Page 32.)
A cranidium from the Hull formation at the Kirkfield liftlock, Ont. Twice natural size. No. 3741.
- FIGURES 3-5. *Bathyurus ingalli* Raymond. (Page 31.)
A cranidium, free cheek, and pygidium from the Hull formation at Kirkfield liftlock, Ont. The cranidium is 1.52 times natural size. The cheek and pygidium are natural size. The cheek is No. 3563a, the pygidium No. 3563.
- FIGURE 6. *Eoharpes dentoni* (Billings). (Page 30.)
A nearly complete specimen from the middle Trenton at Ottawa, Ont. No. 1781c.
- FIGURE 7. *Remopleurides striatulus* (Walcott). (Page 31.)
An hypostoma from the upper part of the middle Trenton at Trenton, Ont. Twice natural size. No. 3758.
- FIGURE 8. *Goldius lunatus* (Billings). (Page 32.)
A cotype, from the upper part of the middle Trenton at Ottawa, Ont. No. 1781c.

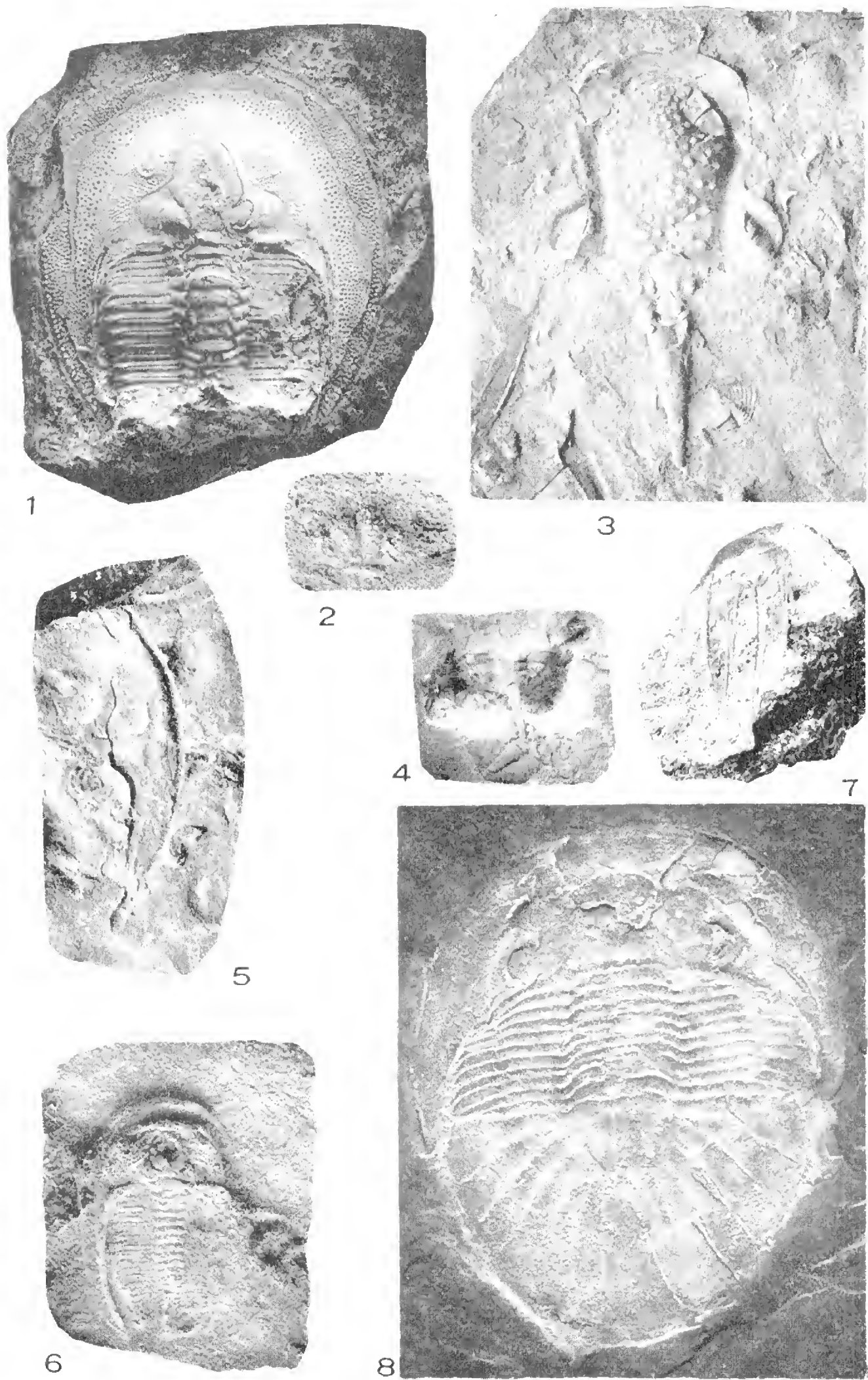


PLATE X.

- FIGURE 1. *Ceraurus dentatus* Raymond and Barton. (Page 35.)
A nearly complete specimen from the upper Trenton (Cobourg) at Cobourg, Ont. Natural size. No. 1769b.
- FIGURE 2. The same species. An incomplete specimen on which the ornamentation is especially well shown. From the Hull formation at Belleville, Ont. Natural size. No. 1769.
- FIGURE 3. The same species. The largest specimen so far found. From the Hull formation at Belleville, Ont. Natural size. No. 8062.



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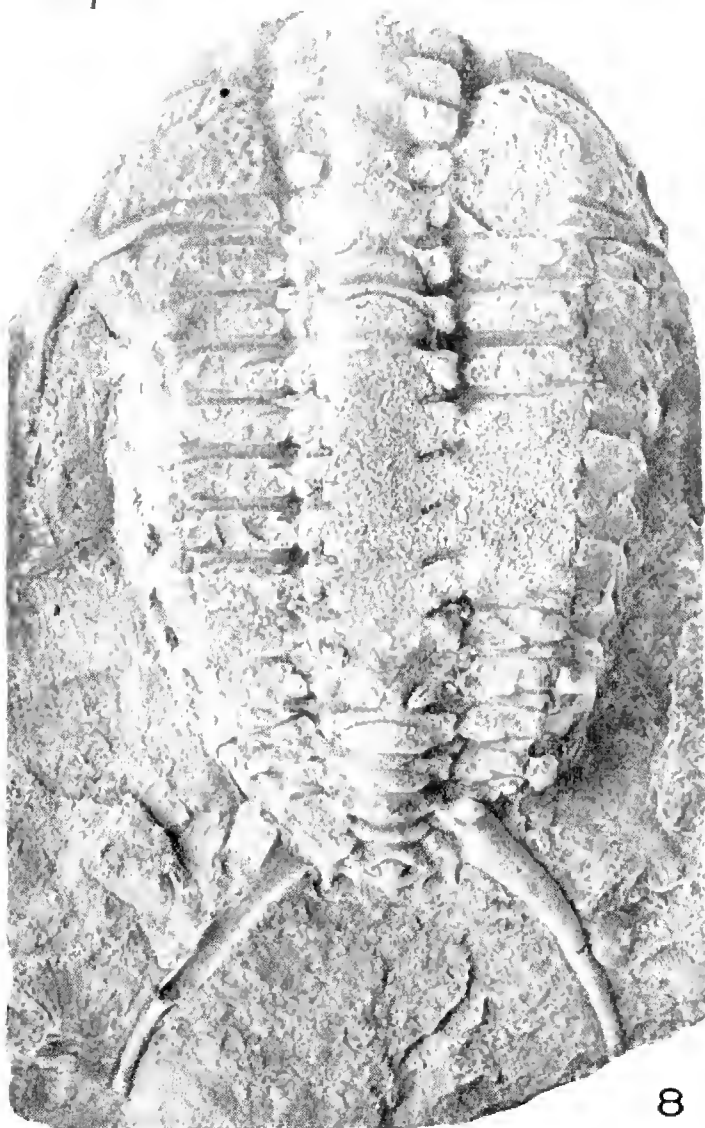
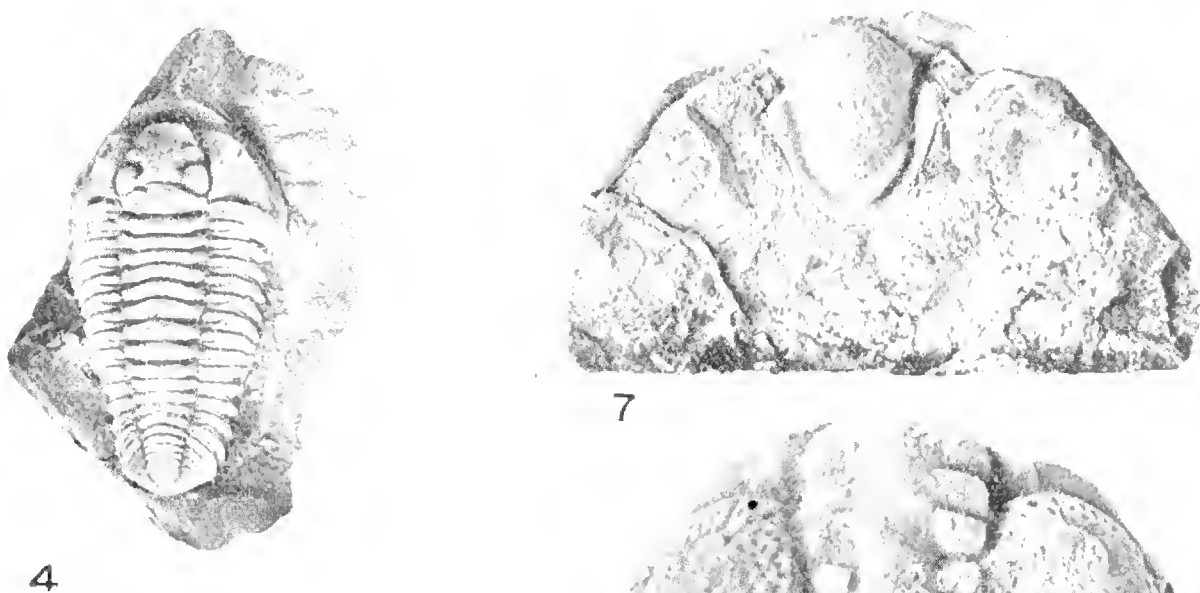
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PLATE XI.

- FIGURE 1. *Cybele spicata* Raymond. (Page 34.)
An imperfect cranidium which serves as the type of this species. From the Collingwood at Craigleith, Ont. Twice natural size. No. 3564.
- FIGURE 2. *Encrinurus cybeleformis* Raymond. (Page 33.)
The pygidium which is the holotype. From the Rockland formation at Kirkfield liftlock, Ont. Twice natural size. No. 3385.
- FIGURE 3. *Dalmanites achates* Billings. (Page 38.)
A nearly complete specimen from the Cobourg, at Picton, Ont. Natural size. No. 3384.
- FIGURE 4. *Calymene senaria* Conrad.
An entire specimen from the middle Trenton, 2½ miles south of Brechin, Ont. Natural size.
- FIGURE 5. *Calymene* sp. ind. (Page 38.)
A young specimen which shows the proparian character of the free cheeks in immature examples of trilobites of this genus. From the shale above the Collingwood at Craigleith, Ont. Three times natural size. No. 3671.
- FIGURE 6. *Ceraurinus marginatus* Barton. (Page 37.)
A cranidium from the Collingwood at Craigleith, Ont. Twice natural size. No. 3566.
- FIGURES 7, 8. *Ceraurus dentatus* Raymond and Barton. (Page 35.)
The holotype, showing the hypostoma in position. From the Trenton at Vankleek Hill, Ont. Natural size. No. 1775.



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